Evaluation of Some Aspects of Telecommunication Networks Interconnection

By

Salwa Hamid Abdel Rahman Mohamed

B.Sc. Honours, Electrical Engineering, University of Khartoum

A Thesis submitted in partial fulfilment for the requirements of the degree of Master of Science in Telecommunication and Information System

Supervisor
Dr. Mohamed Ali Abas

University of Khartoum
Faculty of Engineering and Architecture
Electrical and Electronic Engineering Department

August 2005

Acknowledgement

I am greatly indebted to my supervisor Dr. Mohamed Ali Abas, without his continuous encouragement, guidance and support this work would not have been realised. I really appreciate gaining knowledge from his supervision of this research work.

My acknowledgement is extended to the staff members of the Electrical Engineering Department, especially the MSc course organiser, Dr. Sami Sharif, Dr. Iman Abu lMaaly and Dr. Al Rashid Othman .
Particular thank to Sudatel (my Employer) for support and availing data for conducting this research.

Special thanks to my family for their support and patience during thesis work, in particular my mother, husband, sisters and brothers.

Abstract

The Telecommunication market is expanding rapidly in Sudan. New operators are entering the market. This implies the existence of interconnection agreements between the different operators in order to avoid arise of conflicts. The interconnection agreement between telecommunication operators has three aspects: Technical; commercial; and legal aspects.

This study aims at investigating the interconnection agreement between Sudatel and Mobitel and compare to other international practices.

The research methodology involved literature review of some international telecommunication interconnection agreements, data gathering on existing interconnection between Sudatel and Mobitel. The data was interpreted, analyzed and compared with international agreements.

The study revealed the existence of some drawbacks and shortcomings in the existing agreement between Sudatel and Mobitel. The agreement need to be further revised in its technical, commercial and legal aspects. In addition, the existence of a written agreement is highly recommended.

In order to guarantee a fair market competition between the different telecommunication operators and safeguard/protect the rights of subscribers, the National Telecommunication Corporation, NTC, has a great role to play. NTC has to put the technical, commercial and legal framework that governs and regulates the relationships between the telecommunication operators as well as protecting the rights of the subscribers.

خلاصة

ان عدم وجود اتفاقيات قوية وملزمة للربط بين شركات الاتصالات سبب الكثير من المشاكل الفنية والتجارية والقانونية
ولاهمية هذا الموضوع و نسبة لفك الاحتكار بالنسبة لسوق الاتصالات ودخول شركات جديدة بالسودان تبلورت فكرة هذا المشروع.
ان الهدف من المشروع هو عمل دراسة للوضع الحالي للربط بين سودتل و موبتيل و مقارنة هذا الوضع مع الاتفاقيات العالمية وتوضيح اوجهه القصور وتقديم نصائح بهذا الشان
ولتحقيق هذا الهدف تمت التغطية لنظرية الموضوع وتم جمع معلومات من عدة اتفاقيات عالمية وتم اختصارها كا نموذج لاتفاقيات الربط
وشمل ذلك النواحي الفنية والتجارية والقانونية
ثانية تم جمع و تحليل البيانات عن الوضع الحالي للربط بين شركتي سوداتل و موبتيل ومقارنتها بالاتفاقيات العالمية
خلصت الدراسة ان الوضع الحالي للربط بين سوداتل وموبتيل يحتاج الى مراجعة وتقنين اتفاقيات الربط بين الشركتين من نواحيها الفنية والتجارية والقانونية وان يكون ذلك كتابة وبموافقة الطرفين .
ولكي يتم فتح سوق الاتصالات لشركات جديدة,يجب ان يكون للهيئة القومية للاتصالات دور فعال في تنظيم ووضع قوانين تحكم العلاقات الفنية والتجارية والقانونية بين شركات الاتصالات والعمل على حماية حقوق المشتركين

Table of Contents

Abbreviation

B/W	Both ways
CLI	Calling line Identification
Dest.	Destination
GSM	Global System for Mobile
I/C	Incoming
IN	Intelligent Network
Incoming	Incoming traffic from Mobitel to Sudatel
ISDN	Integrated Service Digital Network
INT.	International Traffic
ISUB	Integrated Service Digital Network User Part
ITC3	Sudatel International Switch at Um Haraz
ITC2	Sudatel International Switch at Khartoum centre
ITU	International telecommunication union
KHC	Khartoum centre Local/ Transit Switch
KHN	Khartoum North Local/ Transit Switch
KHS	Khartoum South Local/ Transit Switch
MED	Medani National Switch
MTB	Message transfer part
NAT	National Traffic
NTC	National Telecommunication Corporation
O/G	Outgoing
OMD	Omdurman Local/ Transit Switch
Orig.	Origination
Outgoing	Outgoing traffic from Sudatel to Mobitel
PDH	Plesiochronous digital hierarchy
POI	Point Of Interconnect
PSD	Port Sudan National Switch
PSTN	Public Switched Telephone Network
QoS	Quality of services
SDD	Sudanese Dinar.
SHD	Synchronize digital hierarchy
SONET	Synchronize Optical Network
SS No. 7	Signalling System Number 7
TSC1	Mobitel Gateway switches at Khartoum centre
TSC2	Mobitel Gateway switches at Khartoum centre
TUP	Telephone User Part

Introduction

1.1. Problem Statement

For more than a century, telecommunication around the world followed a classic model: a national monopoly owned or controlled by country, centrally managed and providing a common public network, by their very nature and tradition, these networks provide a small numbers of standards and nationwide services carefully planned, methodologically executed, and universally distributed. This was exactly the case of modern telecommunication sector, in Sudan, where Sudatel, a state company, dominated the market for more than ten years through a lease term monopoly agreement. However, by the end of Sudatel's monopoly agreement several telecommunication companies entered the market. There appeared the need to regulate the relationships between the different operators, regulate the business and protect the customers' rights.

Given the multitude of entities, their points of intersection are numerous and growing, so the numbers of disputes and issues, technical, financial, operational, regulatory, international and content-wise. The common thread is the transfer of information streams from network facilities of one communication entity to those of another [1].

When Mobitel entered the Market**,** 1996**,** and in order to avoid technical and commercial problems that may arise, a written Interconnection agreement became of utmost necessity to regulate the Interconnection between the two companies. The agreement has to include the following themes: Technical; Commercial; and Legal Specifications. Although Sudatel owns 61% of Mobitel, but still that does not justify the absence of an Interconnection agreement.

Very recently, 2004, the government liberalized the telecommunication market and immediately two more companies (Bashar/tel and Kanartel) will become operational. Under such competitive market situation, the absence of an Interconnection agreement will lead to more problems and conflicts between these companies. There is a real need for powerful Interconnection agreements between the companies. The NTC role is to oblige and supervise the companies put in force such agreements.

Seen the multiple and complex situation caused by the absence of an Interconnection agreement and in case of any conflict between the two companies, it is not at all clear how they are going to address it. Usually it is the role of the National Telecommunication Corporation (NTC) to device Mechanisms and rules that govern the inter-relationship between the telecommunication operators

1.2. Overview

The term Interconnection is defined by the International Telecommunication Union (ITU) as commercial and technical arrangement under which service providers connect their equipment, network and service to enable customers to have access to the customer's services and networks of the other service providers.

The most traditional form of Interconnection has been the Parallel or cooperative Interconnection .In that arrangement, dominant carriers link up with carriers similarly dominant in other regions. Their relation is that of partners and 2-way corresponding, they jointly extend network externalities to their customers and often raise their prices in a joint maximization strategy.

The second classic Interconnection arrangement is Vertical, between a provider that possesses market power in one stage of the transmission chain and another provider that requires use of the bottleneck in order to provide service.

More recently a third type of arrangement has been taking centre stage, that of a horizontal Interconnection, in which competitors for the same markets and customers link up with each other. In the past this situation was suppressed by the stronger of the two parties, often with support of government, sometimes in return for the fulfilment of a number of social obligations of redistribution. In other cases the horizontal participants were kept apart from each other by technology and regulation, as for cable television and telecom networks. Today many governments enable and even promote the emergency of such horizontal Interconnection.

1.3. Objectives

The overall objective of the study is to provide a theoretical, practical and operational set of recommendations for the implementation of the interconnection of telecommunication networks in Sudan. In particular, it aims at studying the existing Interconnection agreement between Sudatel and Mobitel. It is anticipated that the study will provide insight analysis of the drawbacks and losses incurred due to non-existence of an interconnection agreement.

1.4. Approach

In order to realise the above objective the study followed the standard research methodology of: literature review; data and information collection; and analysis and interpretation of the results. Operational data was taken from Sudatel traffic measurement system. Additional data was collected different departments of Sudatel and Mobitel, particularly the existing interconnection design.

A spreadsheet data processing devised for handling and analysing the traffic data in order to identify the technical problem that affects the success of interconnect services.

A comparison between the existing situation, between Sudatel and Mobitel, with some international interconnection agreements was performed.

1.5. Thesis Layout

The output of relevant literature review is presented in chapter two. In particular, information on technical, commercial and legal aspects of interconnection agreements is summarised.

Chapter three presents the case study of Sudatel and Mobitel. It includes the collected data, analysis and interpretation.

The main output of the study, conclusion and recommendations, is presented in chapter four.

2. Specifications

2.1 Technical Specifications

Technical specifications may be applied in the order precedence set out in the relevant regulation as

- ITU Recommendations
- ETSI Recommendations
- National Standards/Specifications

2.1.1 Point of interconnect (POIs) and Interconnection links

This section defines the conditions for the actual connection of one network to another network, the connection at a point of Interconnection (POI)

2.1.1.1 Network Level of Interconnect

This may be realised in a physical way or in a virtual way through a reference network.
Interconnection shall be available at the following levels

- Local level
- Transit level
- International level

The POIs may be associated with the physical network of an operator at the networks design stage at particular points in time alternatively, the POIs may be associated with a system independent structure, that to access to the relevant service may be achieved without detrimental effects.

2.1.1.2 Location of POIs

A POI may be located at one of the three mentioned in the next section. Each party manage that part of the interconnect link which is on its side of the POI. Interconnect links may be self-provided by the operators or procured from a third party.
Physical collocation enables housing on an operators premises of the equipment necessary for Interconnection, such operator grant the other operator or its authorised representatives, access to the equipment at any time, subject to an agreed procedure. Access for routine or planned maintenance may require reasonable notice in advance, but this shall not restrict obtaining immediate access in case of emergency (network failure)

A. POI at One of the Operator's Sites

One of the operators is responsible for providing Interconnect links from their site to the other Operator's site

B. POI at other locations

Both operators jointly provide the interconnect links. The POI may be located at any point (mid point between sites of the two operators or on the site of third party).

C. Extension Circuits

This is an additional interconnect links that extends the interconnect from the point of interconnect to additional operator Switch at a site remote from the initial Switch, this facility uses the additional operator transmission plant to provide the access and is likely to be appropriate for Interconnection with physical network.

2.1.1. 3 Inter Connect link

Interconnect links will be established between the parties to provide the means by which calls and signalling can be passed between the two network. The transmission capacity may be provided by or for one or both interconnect operator.
Arrangement to permit access by one operator of equipment physically located on the premises of the second operator, and related issues of which operator supplies electrical power (AC power or Dc power with battery backup). [2]

2.1.2 Interface Standards

2.1.2.1 Electrical and Physical Interface

Physical transmission media (Optical, Electrical or Radio)

2.1.2.2 Transsimision Interface

The parties shall interface at 2Mbit/s level and in accordance with ITU-T Rec. G703
Plesiochronous Digital Hierarchy (PDH), Synchronous Digital Hierarchy (SDH) and Synchronous Optical Network (SONET)
Bandwidth 64Kbit/s, 2Mbit/s, 34Mbit/s or higher order bandwidth as required. (Multiple 2Mbit/s transsimition circuit can be multiplexed, and brought into an operators Switching centre at high level, 34Mbit/s or 140Mbit/s or more then demultiplexed into individual 2Mbit/s Streams. The agreement shall define the Ownership of the demultiplexed equipment

2.1.2.3 Signalling Interface

Using R2 or SS No.7
Signalling System Numbers 7 (SS No.7) is now widely used. SS No, 7 standards aim at defining Signalling procedures and architectures in circuit Switched networks: PSTN, ISDN, GSM and IN.
Telephony User Part (TUP), which defines the formats and signalling procedure to be used for Public Switched Telephone Network (PSTN) calls and integrated service user part (ISUP), which define the formats and signalling for the Integrated Service Digital Network (ISDN), and Global System for Mobile Communication (GSM) basic calls and supplementary services. These standards are appropriate for the Interconnection of

different network in the same country for the provision of fixed or mobile voice telephony services.

A. **SS N.7 Layers**:

a) Messages Transfer Part (MTP)

The MTP shall conform to ITU-T rec. Q701---Q707
The MTP shall allow messages from all different users to be transferred on the same signalling data link

b) Integrated Service Digital Network (ISDN) user part (ISUP)

ISUP following ITU-T Rec. Q.761 to Q.766 is used to support basic bearer service and supplementary services for voice and non-voice applications.

B. Signalling Inter working and Compatibility

It should be ensured that networks with different signalling types (even within the same type of signalling) work together without any signalling failure or any other signalling problems. [3]

2.1.3 Network Synchronization:

The need for synchronization arises with the introduction of digital techniques.
Especially SDH and SONET connection need clock synchronization
Loss of information is often caused by poor synchronization
Clock errors leads to slip I.e. loss of frames and repetition, which causes: Noise, Transsimision losses, Bit error
A digital multiplexing and demultiplexing needs synchronization in order to distribute the single channels to the correct targets
A data packet signal doesn't need synchronization. Each packet contains information from one source and has information about the start of the packet.
There are many type of synchronization:

- Distribution of the clock over special synchronization links
- Distribution of the clock by utilising traffic links
- Use an independent clock in each node
- Use an international navigation system in each node
- Combine some of the upper four methods. [2]

2.1.4 Services

Interconnect call services are provided in order to allow any to any communication,
where customers of one operator can call customers of another operator.
Interconnect services are provided in order to allow customers connected to operator's network to access services offered by another operator, possibly in competition with first operator. Furthermore, some interconnect services may be provided by an operator on a fully competitive basis as alternative to other ways of meeting demands

The following is not an exhaustive list of services. For each service in the interconnect agreement, principle of charging and call handover shall be defined. [2]

2.1.4.1 Data Management Amendments

Access to each other's telephone numbers will be achieved by implementing data management amendment in the networks. This is necessary for access to both geographic and non-geographic numbers. Adequate testing shall be conducted to verify that access has actually been enabled

2.1.4.2 Conveyance

A. Local

Operator B will terminate in its network any calls passed from operator A customers where the terminating numbers belongs to operator B. The calls may originate in operator A network, or in another country with connection to operator A. Operator B charges operator A for the termination service,

B. International Conveyance

Operator B will convey across its network, any calls passed from Operator A customers, where the terminating numbers belongs to an international operator having a corresponding agreement with operator B.
Operator B charge operator A for the termination service

C. National / Transit

Operator A passes call to Operator B, for termination in the network of Operator C. The calls are terminated in a network other than operator B.

D. Special Telephone Service

Operator B will terminate in its network any calls passed from operator A customers where the terminating numbers belongs to operator B service provider (can be a service provider business of Operator B or a third party service provider). The calls may originate in operator A's network, or in another country with connection to operator A networks, Calls may be specially tariff numbers translation service Calls, such as free phone and premium rate Calls, with services from both interconnecting parties

E. Access to Local loop

This enables access directly to the individual customer line, to permit conveyance of calls between the customer and the other operator.

2.1.4.3 Operator Assistance Services

The call will be passed over to the operator assistance at a numbers of specified connection points, Service will not discriminate of different operator.

2.1.4.4 Directory Enquiry Services

The call will be passed over to the directory enquiry provider. at a number of specified connection points. Service will be not discriminate between customers of different operators.

2.1.4.5 Emergency Services

Customers of all operators can pass their customers emergency service calls to the emergency service provider. They will handle and pass to the correct authorities.

2.1.4.6 Numbers Information System and Services

The numbers of all operators must be allowed in a numbers information system database. It is source of phone books and directory assistance information.

2.1.4.7 Phonebook and Directory listing

Operator buys directories from the providing operator, for distribution to their customer. Nothing in the Interconnection agreement shall be read to require an operator to have a printed directory. It shall be possible for customers of one operator to have a listing in another operator's directory.

2.1.4.8 Calling Card / Charge Card Facilities

This will enable all operators to provide their customers with access to another operator's charge card platform to enable calls to be made and charged to the calling card/charge card.

2.1.4.9 Numbers Portability

The numbers portability is a facility, which allows a customer to keep his/her telephone numbers in circumstance where traditionally, the customer would have to change his/her numbers.
The introduction of numbers Portability is a major undertaking, which requires planning and co-ordination between operators, both for technical and commercial aspects.
Particularly, the recovery of any costs incurred by the parties involved shall be addressed at an early stage

A. Operator Portability

Allow customers to keep their telephone numbers when changing the operator they buy their telecommunication service from when they remain at the same geographic location.
The facility can apply to all classes of numbers, PSTN, ISDN, free phone and specially tariff numbers, translation service numbers, personal numbers, and Mobil numbers.

a) Call Forwarding

It uses existing Switch software and is implemented by simply (data filling) the donor Switch with prefix code for the porting customer. It does however use two numbers and is inefficient in routing terms

B) Code Prefix

Code prefixing attaches a prefix to ported numbers, identifying the new host Switch, therefore using only one numbers per customer. It can be implemented in various ways.

c) IN Solution

With IN solution, a Switch in the originating operator's network interrogates a shared database to discover the identification code of the terminating Switch early in the call set-up chain.

B. Geographic Portability

This allows customer to keep their numbers when moving house or business premises could be done in combination with operator Portability.
The technical options for introducing of Geographic Portability are still being explored, though it is likely that an IN solution would facilitate this.

2.1.4.10 Access Service

Access is the general service provided by the operator serving the calling customer. Operator A providing physical connection to the other party operator B, enabling the calling customer to access services offered by operator B.

A. Carrier Selection (Indirect access)

For indirect access, a directly connected customer of Operator B would use specific access code to access Operator A. Operator B will implement data management amendments into Their network so that whenever the code is dialled .it will be recognised and the call forwarded immedediatly to the operator A
Operator A will pay Operator B for the originating part of the call.

B. Carrier Pre-Selection

Is required to allow end users to choose in advance their preferred default carrier on the networks of those local access providers designated as having Significant Market Power. Short access code shall be allocated.
Carrier Pre-Selection shall be available to all customers (PSTN, ISDN, Data and Local), National and international. According to the agreements the bills can send directly to customers

2.1.4.11 ISDN/GSM Supplementary Services

There are three types of ISDN/GSM Supplementary services

- End to end ISDN supplementary services between fixed network
- End to End GSM supplementary services
- Common ISDN/GSM supplementary services between a fixed and a mobile network

2.1.4.12 Access to Service providers

For new service introduced by a third party operator, or service provider, where the operator with significant market power it is usually the first to be able to reach commercial agreement for access an issue to consider is interconnect access to a transit service offered by the operator with significant market power to access the new service of the relevant third partly.

2.1.4.13 Advanced Services

There are tow types of Advanced Services

- Virtual Private Networks (VPN) services
- IN advanced services (Free phone, premium rate, Virtual calling card, UPT)

2.1.5 Intelligent Network Interconnection (IN)

This section deals with the Interconnection of advanced services such as Cashless Calling, Call Forwarding, Credit Card Calling, Prepaid Calling Card, Prepaid Account Telephony, Numbers Portability, Universal Access Distribution, Universal Personal Numbers, Wake Up Service, Conference, Voice Mail, Prepaid Internet Access, Split Charging service and any other related Value added service, to offer such service to Customers of other operators. [2]

2.1.6 Numbering

The allocation of numbers is matter for the National Regulatory Authority. In Sudan the National Telecommunication Corporation (NTC)**,** the implementation of allocated numbers is a matter for the Interconnection negotiations:

- Common and non-discriminatory geographic codes
- Common and non-discriminatory use of key non-geographical codes eg. Free phone
- Short access codes for indirect equal access.
- Allocation of signalling points where appropriate

The Procedure for implementing numbering changes required as a result of decision of the national regulatory authority also transfer of numbers and numbers series. [2]

2.1.7 Calling line Identification (CLI)

This section shall define condition under which an operator will convey CLI to another operator
The purpose for which the receiving operator (billing, call routing, display and validation may use the CLI
Possible restrictions on the use of CLI including (Numbers Presentation) (CLR)
Free use of (CLI) for signalling and billing purposes.
The dummy CLI for mobile operators must be specified. [2]

2.1.8 Quality of Services (QOS)

This section shall define the Quality of Service parameters that the parties shall meet, the way to measure the actual performance and the consequences of not meeting the agreed figures.
Quality of service provision shall be in the agreement, stating a minimum standard service that is applied to the operators. This shall subject to strict contractual terms and condition. Interconnection traffic shall not be discriminated in relation to other comparable traffic in the network of an operator and alternative routing shall be available in the event of equipment failure in either failure of a particular. [2] Interconnect link.

2.1.8.1 QOS for Telephony

Calls passed across POI shall be conveyed in the receiving network and routed in accordance with the same routing principals and to the same quality of service as comparable Calls originating within that network, measuring the percentage of successful relevant calls for ingress traffic. Calls are defined as being unsuccessful if they fail due to network problems such as congestion. Where calls failure is due to customer behaviour such as engage numbers and no answer numbers they will not be consider unsuccessful. In cases of network failure, procedure for alternative routing shall be agreed and utilised.

2.1.8.2 QOS for Interconnect links

May be specified in Interconnection agreement or in other agreement (e.g. leased line contract) depending on the way the links are arranged, The measure chosen shall include an average measure with an index that takes into account the times in cases, which are significantly better or worse than the average.

2.1.8.3 QOS for Data Management

Target times for implementation of numbers order to and similar, Measured from the date of receipt of valid order to service provision, consistent with the terms of the interconnect agreement.
Each operator must follow the ITU standard for quality of services ITU-T (E820, E.830, E845, E846.P48 and D2048)

2.2.9 Network Design

This section shall describe, or make reference to relevant network structures of the interconnecting operators and define principles for Call routing.
This section shall also define principles for interconnecting SS no.7. [2]

2.2.9.1 Speech Routing

Interconnection link may comprise different types of circuit groups. The circuit in each circuit group will convey traffic in a specific direction according to the agreements: One way (Incoming, Outgoing) or both way

Architecture

Operators shall switch network configuration about its network to the extent necessary to perform network planning and planning of POIs. This includes a full listing of the Switches and associated numbers ranges where physical network Interconnection is used. The addresses of POIs, shall be made available .In both cases, the information shall include information on the technical interface, Switching technology (digital or analogue) and Signalling system and etc.

2.2.9.2 Call Routing

Normal call routing shall be such that Calls passed from another operator are conveyed in accordance with the same routing principals as comparable traffic within the network .the parties shall define the rules for routing traffic in normal and abnormal situations including dealing with overflow, congestion and network management.

2.2.9.3 Signalling Routing

The direct signalling routing and alternative routing whether using Signalling transfer points or not

2.2.9.4 Information

Where charges for service are based upon zones or Switch's boundaries the parties shall switch the relevant data without charge.

2.1.10 Network Planning

This section shall define principals for the continuous planning process that must take place between the interconnecting parties. The planning process shall include:

- New POIs
- Planning and design of the interconnect link.
- Type of circuit group (Uni-directional or Both way directional)
- Changes the topology of the networks
- Changes to the transmission capacity at each POI during an appropriate planning period
- Detailed rules for call routing (principles defined in (network design)

- Change on the signalling network
- New numbering blocks
- New services
- The process shall define timing requirements and information Switch requirements. Contingency arrangements will also be established in cases of network failure. First and second choice routing will be agreed including the provision of redundancy between the relevant Switch connections.
- Methods of network management (such as call gaping) will take place.
- Provisioning time scales shall be included.
- Signalling point codes (SPC) and the numbers of signalling links must be specified.

2.1.11 Forecasting

- The parties must forecasts the amount of traffic expected over all interconnect links. Based on this forecasts and the QoS requirements, the capacity for the different routes shall be planned.
- They must be sufficient time for forecasts capacity to be implemented (6 month or more) depend on the agreement forecasts delivery time.
- If any party seeks interconnect capacity at a level other than the forecast or on forecast delivery date other than the agreed forecast delivery date, it may make request to other party to study the feasibility of such a request
- Delivery of interconnect capacity is taken to occur on the forecast delivery date or on such other date as may be agreed.
- Capacity orders placed will be contractually binding on both parties, though some flexibility shall be built in, during the early days of interconnect.
- The actual usage of the interconnect capacity must be greater than or equal to ninety (**90**) **%** of its forecast, no over forecasting charges shall apply. If the actual usage is less than ninety (**90**) **%** the requested party shall pay for the unused capacity
- The parties shall use their reasonable endeavours to ensure that its network Facilities on its side of the relevant POI are provisioned on the forecast delivery date (or as otherwise agreed) and maintained in accordance with forecasts. [3]

2.1.12 Network Protection and Safety

The parties shall define their respective obligations to protect each other's networks and define measures to prevent endangering people. [2]

2.1.12.1 Network Integrity

Network integrity is a question of network management and the ability of the network to maintain certain characteristics with regard to performance and reliability.

- The interfaces between the networks must conform to national/ international standards. Those standards shall be open and monitored by an independent body.
- Compatibility measures shall ensure that networks or systems with different levels of performance work together correctly.
- Testing procedures shall be carried out before Interconnection and possibly after Interconnection but before brining into Service.

- Special national/international technical solutions might be introduced for the Interconnection of networks
- All testing shall carry out within a reasonable period of time and subject to mutually – agreed principles so as not to delay Interconnection.

2.1.12.2 Operation

- Each partly shall be reasonable for the safety and operation of its own system
- There shall be points of contact and escalation procedure to guarantee a rapid, non-discriminatory response in case of faults.
- Do not damage, interfere with or cause any deterioration in the operation of the other's party network.

2.1.12.3 Monitoring

- Every network operator shall be informed at all times about the condition, status of his network and shall pass on relevant information to other interconnected operators in order to be able to identify and clear faults and overload rapidly.
- Do not endanger the safety or health of any person, including the employees and contractors of other party.
- Each party shall ensure that its network and operating procedures comply in all respects with this agreement.
- Nothing in the agreements shall oblique either party to do any thing, which would cause it to be in break of any statutory, regulatory or contractual obligation of confidentiality or any code of practice on the confidentiality of information issued by the Authority or pursuant to their respective licences.

2.1.13 Installation and Testing

This section shall define procedures for installation and testing for initial Interconnection, as upgrading Interconnection facilities .It shall also define the principles for continuous operation of the Interconnection, including network and traffic supervision, fault and disturbance reporting and fault recovery action.
The need for testing interconnection hardware and software results from the common interest of both networks in maintaining network integrity, testing also help to verify the interoperability of services as well as to ensure a reasonable quality of service and continuous service provision to the customer. [2]

2.1.13.1 Testing

The purpose of the interconnect Testing is to provide reassurance the party's network can inter-work correctly.
Prior to the conduct of interconnect testing each party shall fully tested its network

A. Testing Items

- First Interconnection of networks
- A new POI

- Introduction of new Interconnection Switching system type
- Hardware, software are change with the interface relevance
- Introduction of new supplementary services
- Introduction of additional capacity to existing Transmission system, Signalling links, Signalling route, Switches.
- Test and monitor the performance of the network.

B. Types of testing for SS No. 7

a) Validation or Conformity Testing

The goals are to ensure conformity of hardware/software with national /international standards. system is testing in isolated operation according to standards test specifications (national and/o Q specifications ETSI).

b) Interworking or Interoperability testing (in a test network environment)

The system of both operators are interconnected and tested for interoperability at the network interface. The basis for the test is standardised national/international specifications ITU/ETSI (IT REC.Q763, ITU-T Rec. Q764 and ITU-T Rec. Q767

c) Interoperability or Stability testing (in the operational network)

- The interoperability of services (e.g. billing) is observed for certain time period to determi stability. Using a limited numbers of systems and possibly a limited numbers of customer carries this out.
- Each party shall be reasonable to test and monitor the performance of its own network. Testing of the Interconnection link and signalling links shall be kept to a minimum and sh avoid the busy hour periods and this test must be carried out under the agreement betwe the parties.
- Both parties shall agree upon the details of the testing required. Test numbers and conta point shall be switched to facilitate the testing.

d) Commissioning Testing

- This test consists of simple functional testing of hardware and software to identify any faults with specific equipment, software or data fill. This may be carried out when new interconnect routes are introduced, or capacity on a route is augmented.
- Interconnect testing between the operators shall be carried out as speedily as possible and in accordance with transparent testing costs applicable to all operators.
- The required test date and the duration of the test must be specified in details and agreed by both party.
- The parties shall act in a good faith and make reasonable endeavours to complete all test items within the estimated testing period.
- The party, which is responsible of the delay in completing testing, shall pay to the other party for that delay. [2]

2.1.14 Decommissioning

- When one party decide to decommission any POI must notify the other party about the reason and at a sufficient time before the date of decommissioning.
- The decommissioning party shall bear all direct costs incurred by both parties in charring out the decommissioning.
- Upon the happing of an event which causes or is likely to cause significant damage to the network of the other party or is likely to endanger the health or safety of any person (Emergency Event), that party may close or replace its SGS or a POI or decommissioning an interconnect link without prior written notice to the other party, provided that it notifies the other party as soon as practicable that the emergency event exists and that emergency relocation work is being or will be performed. The costs incurred as a result of or in connection with, a closure or replacement of an SGS or a POI or decommissioning of an Interconnection link under this sub-clause shall be borne as follows: Where the occurrence of the emergency event was caused as a result of the negligence or wilful act or omission of the first- mentioned party, its employees, agents or contractors that shall bear the costs associated with the closure, replacement or decommissioning incurred by both party. Other wise each party shall bear its own costs associated with the closure, replacement or decommissioning. [2]

2.1.15 Operation and Maintenance

An operation and maintenance manual shall be drawn up by the parties detailing the responsibilities, methods, and the procedures for the operation and maintenance system at the required quality of service. [2]

2.1.15.1 Fault Reporting

- If either party identify a fault in its network may have an adverse effect on the other party's system, the party which first becomes aware of the fault shall promptly inform the other party. The party in whose system the fault has arisen shall promptly inform the other party of the actions being taken to resolve the problem.
- The parties shall develop and record in the operations and maintenance document a series of agreed response times for different fault conditions.
- Service restoration shall take priority over the clearance of faults not affecting service.
- The party in whose network the fault arises shall, if possible, rectify the fault immediately. If not. The other party shall be notified and kept informed of progress on a regular basis.
- Each party shall provide sufficient notice of any planned maintenance which may affect the other party's system and also each party shall try to minimise disruption.
- Both parties shall co- operate in any investigation and follow up actions and keep each other informed on the status of the progress of the fault
  Clearance in timely manner, also both parties shall establish 24hour contact Points

2.1.15.2 Type of Fault

Transsimision fault, Signalling fault, Gateway Switch fault and any fault in the local network, which may affect the traffic between the operators.

2.1.16 Change in the Network

- This section shall define the principals for dealing with changes in the system of one operator that may be an impact on the system of the other operator. Issues that may need to be specified are:
- The altering party shall notify the other party as soon as is reasonably practicable of a propose network change. The period of notice must be at least Six (6) months or an any agreed period unless a shorter notice period is agreed between the parties in writing such notice shall as far as possible, see out details of the nature, effect, technical details and potential impact on the other part's network of the proposed network change, as such other information as the other party shall reasonably require. The altering party shall be reasonable for the reasonable and direct cost of such change in the other party's Network, and shall pay to the other party such costs, exception to this would be in case where the change is agreed or where the alteration is part of a planned upgrade program.
- This will apply in four general circumstances: Physical network Change, Software change, Signalling Change, Signalling and Software upgrade. [2]

2.1.17 Provision of Information

This section shall define rules for providing information on the existing network e.g, network structure and interface. Information shall be provided on planned Changes to the network structure or hierarchy, as well as planned changes to transmission and signalling systems that may impact other operators.
For the avoidance of doubt, the information that is proprietary, Confidential or Commercially sensitive must not be provided. [2]

2.1.18 New Requests for Interconnection Services

Three categories of new Interconnection service have been identified as follows:

- Any Interconnection service already provided
- Any service already provided by an operator to itself
- Any service not provided at all by the operator to whom the request is made
- This shall apply to both parties, as it is relevant at least to all new interconnect Services, regardless of initiator, and could be widened to recover all new interconnect services .It covers the process of implementing a new service where full commercial agreement may not yet have been reached.
- The aim of negotiation is to incorporate an additional service into the interconnect agreement
- The parties shall negotiate in good faith and use efforts to reach agreement as soon as possible. Within agreed time scales, after a request for interconnect has been accepted or is obligatory, if agreement is not reached temporary prices shall be

applied, to prevent unnecessary delay to the launch of new services. These prices shall be retrospectively adjusted when the price is finally agreed or determined.

- Given the early stage of liberalisation of some markets, it is not clear whether these illustrative timescales can be met; the timescales shall be reviewed in the light of experience. [2]

2.1.1.19 Implementation Time

- Detailed contractual time scales.
- Any non-contractual time scales shall be clearly defined.
- Time scales may be dependent on the capacity ordered and the amount of associated planning.
- Additional capacity on exisiting routes must be provided more quickly than capacity on new routes. Reasonable flexibility in capacity ordering shall be permitted in the early stages of planning a new Interconnection link.
- It is common and desirable for the operators to provide periodic forecasts of circuit requirements for Interconnect links. Joint planning is necessary to ensure acceptable schedules quality. [2]

2.2 Commercial Specifications

2.2.1 Charging

This section shall define the charging principles applicable to Interconnection links and services. Principles shall be defined for facilities used by both parties e.g. interconnect links used for both way traffic.

- All charge payable shall be calculated according to given agreed charge between the two parties.
- The price of Calls depends on its type (Originating calls, Terminating calls, Transit calls, National calls, International calls, Pre paid calls, Data message, Internet session, etc.
- The date of the pay must be clearly specified between the parties.
- Per Call charge or other charge method e.g. flat charge
- Chargeable Call elements e.g. conversation time of successful Calls
- Time of day, time of week variations
- Mechanisms for reviewing and changing interconnect prices
- Payment (subject to any Call set-up fee) shall commence with the receipt of the answer signal, and terminate with receipt of the release signal.
- Call set-up fees, if and where applicable and cost justified, could be incorporated either through conversation time charging or as a separate identified element.
- Where charges are cost based as required by regulation, and then all charges raised shall be on the same costing principles and cost allocation basis.
- Interconnection charges shall be kept separate from any United Service organizations (USO) contributions and or access deficit contributions as may be applicable.
- Interconnecting operators shall only pay for those elements of the network that are necessary for the service agreed they use. This shall be duly taken into account in the charging structure, which shall reflect optimum routing factors.

- Because the total cost of Interconnection is very dependent on the location of points of Interconnection, Interconnection pricing shall enable new entrants to plan their points of Interconnection in a way that allows them to minimise these costs.
- Interconnection pricing may be subject to review on a retroactive basis (to resolve a dispute or reflect contemporaneous pricing.
- Accounting rates must be share between the two operators. [2]

2.2.2 Billing

This section shall be defined the principles and procedures for collecting billing information and settling invoice between the parties. All billing system shall be capable of being audited and tested to verify their accuracy
All invoices shall contain the Billing Verification Information as stipulated in the individual service schedules. Each party shall use the Billing Verification only for the purposes of verifying the accuracy of amounts charged on an invoice. [2]

2.2.2.1 Recording of Billing Information

- Both parties shall consider what the billable call for interconnecting billing purposes.
- The format and content of the billing information shall be agreed prior to service e.g. information for each individual Call, or in bulk format
- Both parties shall have the mechanism for recording billing information, to enable checks to be made. The data presented shall tie in with the agreed method of pricing (e.g. with chargeable Call duration recorded
- Need to account for times where one Call covers two different charge rate periods
- Call accounting shall be detailed for each individual POI
- Agree procedures to recognise potential difficulties with specific services, e.g. transfer charge Calls.

2.2.2.2 Switch of Billing Information

- Need to reconcile records of accounts and agree on invoicing channels
- Agree upon the physical media for interchange of data and the data protocol
- Dates for switch shall be pre-defined on regular basis
- Need contingency plan for circumstance where one or the other billing system fails.

2.2.2.3 Invoicing and Payment Procedure

- Payment periods must be defined, with time scales for payments
- Deal with procedures for payment of transfer charges calls including provision for collecting from the prevention of fraud.
- Interest payments in cases of default or disputes
- Procedures for refunds if applicable
- Dispute, escalation procedures
- Bad debt procedures. Normally, each operator is responsible for collecting from its customers and absorbs any bad debts of its customers
- Rights to terminate Interconnection service in the event of a billing dispute shall not normally exist. [2]

2.2.3 Pricing of Interconnect

Regulated Pricing Have Interconnect Examples: [1]

2.2.3.1 Zero-Charge (bill-and-keep) And (lump- sum) Payments

Two networks might agree to a zero-charge where traffic and costs between the entrant and the incumbent are balanced, and where it therefore would be administratively easier to impose no charge.
Since costs are not passed on, each carrier has an economic incentive to increase the efficiency of its own network. At the same time, each firm will also try to maximize its outgoing calls in relation to the incoming traffic to divert its traffic to the other carrier as soon as possible, and to discourage usage of its own network. Bill-and-keep also has problems when originating and terminating usage proves unbalanced.

2.2.3.2 Average Cost Pricing

All cost-based pricing methods have the administrative advantage that they require
Only information about the providing network and not about users and Interconnection prices can be set at the average cost of providing such Interconnection.

2.2.3.3 Fully Distributed Cost Pricing and two-Part Tariffs

Fully distributed cost pricing (FDC) tries to combine the economic incentives of marginal cost pricing with a way to cover the fixed costs. In theory, it combines all costs common fixed and incremental and allocates them to different services such as to local and long-distance; residential and business according to a formula. The cost per unit for service related items is usually based on telephone message minutes or message minute miles. For many years, FDC was the dominant method of step-by-step regulation.

2.2.3.4 Price Caps

Price caps can also set interconnection prices. In principle, such cap can be tacked on to any pricing scheme except where such a price is zero. A given Interconnection price, however derived, is then indexed to inflation, productivity expectations, and other factors. A high productivity factor would in time lead to low prices. A price cap system provides incentives for cost reduction, because a carrier would gain by cutting cost.

2.2.3.5 Ramsey Pricing

This pricing rule recommends that when marginal cost pricing will not recover total cost, to institute a price discrimination in which each customer class is charged a price inversely proportional to its demand elasticity.

The basic intuition behind Ramsey prices is that to allocate fixed costs among al Customers. [1]

2.2.3.6 Marginal Pricing

In a fully competitive market, long-term marginal cost pricing is optimal in terms of economic information on the elasticity for different customer types must be available as well.

2.3 Legal Specifications

The legal interconnection must include:

- Interpretation: historical background (commonly called recitals) and definition of key terms
- Scope of interconnection
- Application laws
- Disputes resolution

2.3.1 Dispute

By international standard and practice, interconnection Disputes resolved by the Regulator. [3]

2.3.1.1 Billing Dispute

A billing dispute may only arise when any party has reasonable grounds to believe that the error has arisen from one of the following circumstances:

- The Billing System has been defective or inaccurate in respect of the recording of the Calls.
- There is or has been, a discrepancy between the invoice in dispute and the records generated by the other party
- There is or has been, a fraud perpetrated by the other party
- The other party has made some other error in the respect of the calls or calculation of the charges which are the subject of the billing dispute

Billing dispute notice must specify:

- The reason for which the party disputes the invoice
- The amount in the dispute
- In respect of disputes initiated by customers a copy of the customer's written complaint
- Details required to identify the relevant invoice and charges in dispute including: The account numbers, the invoice reference numbers, the invoice date, the invoice amount, the detailed billing verification information .For the avoid of doubt, no invoices may be disputed after the expiration of billing Dispute Notification Period

Other Disputes

The term and conditions apply to any disputes other than the Billing disputes

2.3.2 Dispute resolution (Billing and other)

2.3.2.1 Initial Escalation Procedure

- The party will initially raise issues arising under the agreement with each other by exchanging correspondence with a view to resolving any such issues through those means.
- If the parties do not reach an agreement on an issue raised through correspondence under agreed period, either party give written notice (at notice period) to the other party of its intention to escalate the issue and outlining the details of the issue. If the issue is not resolved prior to the expiry of the notice period, then either party may notify the other party (receiving party) that it wishes to refer the issue for discussion to an Inter-Working Group.
- In the event that a dispute is referred to an Inter- connect group, the parties shall promptly form a committee with an equal numbers of appropriate representative from each party.
- If Inter-working group has not resolved an issue within a given agreed period the party may refer the dispute to:

2.3.2.2 Authority

- Dispute will only be referred to the Authority if the provision in Initial Escalation Procedure have been complied with
- The resolution of a dispute referred to the Authority will be conduct in accordance with the COP
- If the Authority: Does not have the power under the act of the COP or is unwilling to resolve the dispute, the Authority will refer the dispute back to the Inter-Working Group

2.3.2.3 Mediation

- A dispute will only be referred to the Mediation if the provision in Initial Escalation Procedure has been complied with.
- Any referral of a dispute to mediation must be made by notice, including a statement of the matters in the dispute.
- The Mediation must be conducted in accordance with Mediation rules and this clause for the time being in force, which rules are deems to be incorporated by reference into this clause. In the event of any inconsistency between them, the provocations of this clause shall prevail. Mediation are to be conducted in private
- In addition to the qualifications of the mediator contemplated by the mediation rules, the mediator should:
- Have an understanding of the relevant aspects of the telecommunications industry (or have the capacity to come to such an understanding quickly
- Not be an Officer, director or employee of a telecommunication company or otherwise have a potential for conflict of interest.

- The parties must notify each other no the later than 48(or any short time agreed by both parties) hours prior to mediation of the names of their representative who will attend the mediation. Nothing in the sub clause is intended to suggest that the parties are able to refuse the other's chosen representatives or limit other representatives.
- Mediation settlement agreements or the information in them are to be published or published only with consent of all parties and in term agreed by the parties.
- The mediation will terminate in accordance with the mediation rule.
- Any parties will bear their own costs of the mediation including the costs of any representatives and will each bear half the costs of the mediator.
- If the parties fail to reach an agreement in a mediation held under this clause, they may, by mutual agreement, refer the matter to Arbitration.

2.3.2.4 Arbitration

- A dispute will only be referred to the Arbitration if the provision in Initial escalation procedure has been complied with.
- The Arbitration will be referred to and finally resolved by arbitration in the country in accordance with the Arbitration Rules, for the time being in force, which rules are demes to be incorporated by reference to this clause. In the event of any inconsistency between the rules of Arbitration and this clause, the provisions of this clause shall prevail.
- Once a dispute is referred to Arbitration, it may not be refered to conciliation
- The arbitral will consist of one Arbitrator to be appointed by agreement of the parties. The arbitrator:
- Will have the appropriate qualifications and experience to arbitrate the dispute, including knowledge of the telecommunications industry and legal qualifications
- Need not be from a country or resident
- Will not be an officer, director, or employee of a telecommunications company or otherwise have a potential for conflict of interest
- The following procedure will apply to the Arbitration:
- The parties will present written submissions to the Arbitrator and each other within a specific period of Business days of the appointment of the Arbitrator
- Each party may respond to the other's submission in writing within a specific period of Business days of the date of other party's submission
- At the request of either party and subject to the parties agreeing or the a Arbitrator deciding within a specific period of Business days of the last written submission that the Arbitration be by documents only, an arbitral hearing will be held within a specific period of Business day of the last written submission.
- Should a hearing be held, each party will have the right to appoint one Expert to appear at the arbitral hearing and will have the opportunity of making an oral submission. The arbitration will be conducted in private.
- The procedure of the arbitral hearing will be determined by the arbitrator (including numbers and duration of oral submission by the parties and Experts)
- The Arbitrator will not have the power to appoint any experts.
- The Arbitrator will deliver his award within a specific period of Business days of the arbitral hearing or the last written submission where the Arbitration is by documents only.

- Every dispute referred to arbitration will be arbitrated separately such that is by documents only
- The Arbitrator's decision will be binding on the parties (in the absence of the manifest error of the fact. [3]

2.3.2.5 Judicial

The two parties are at liberty to seek judicial review of the arbitration's decision at the Federal High Court, after exhausting all regulatory process, Arbitration's decision remains valid and binding until a contrary decisions given by the given by the Federal High Court.
The network remain interconnected at all times until the disputes resolved

3. Sudatel and Mobitel as Case Study

3.1 Introduction

This section aims at studying the existing Interconnection agreement between Mobitel and Sudatel.
When Sudatel started, 1994, there was only one Telecommunication Company, so there was no need for an Interconnection agreement. When Mobitel entered the Market and in order to avoid technical and commercial problems that may arise, a written Interconnection agreement is important to regulate the Interconnection between the two companies. The agreement has to include the following themes:

- Technical Specification
- Commercial Specification
- Legal Specification

When we began data and information collection about the existing Interconnection between Mobitel and Sudatel, we unfortunately discovered that such a written Interconnection agreement does not exist. However, there is only a weak agreement that covers pricing and rent of transmission equipment, and does not cover all the aspects of a commercial agreement between two operators.
Although Sudatel owns 61% of Mobitel, but still that does not justify the absence of an Interconnection agreement.

At present there are many problems Include:

1. Technical problems:

- Synchronization
- Signaling
- Congestion
- Trunk busy
- Wrong routing
- No planning
- No traffic forecasting
- No network protection and safety
- No agreement for all services, and
- Others

2. Commercial part

- Charging
- Billing
- Pricing

3. Legal part

- Historical background (commonly called recitals) and definition of key terms
- Scope of interconnection
- Application laws
- Disputes resolution

And also both Sudatel and Mobitel are now using different types of switches and signaling, which lead to many technical problems (Incompatibility).

Seen the multiple and complex situation caused by the absence of an Interconnection agreement and in case of any conflict between the two companies, it is not at all clear how they are going to address it. Usually it is the role of the National Telecommunication Corporation (NTC) to device Mechanisms and rules that govern the inter-relationship between the telecommunication operators

However, it seems that NTC has so far not exerting its full power of authority that obliges the telecommunication operators to put forward such agreements**.**

Very recently, 2004, the government liberalized the telecommunication market and immediately two more companies (Bashartel and kanartel) will become operational. Under such competitive market situation, the absence of an Interconnection agreement will lead to more problems and conflicts between these companies. There is a real need for powerful Interconnection agreements between the companies. The NTC role is to oblige and supervise the companies put in force such agreements.

As we are concerned with the Interconnection between Sudatel and Mobitel, there should be a written Interconnection agreement under the auspices and endorsement of NTC in order to regulate the Interconnection and cater for subscriber's rights. In order to play the above assigned role, the NTC must act as a third party in each Interconnection agreement. Whenever a conflict arises between the two companies and they fail to resolve it, then the case could be referred to NTC.

Also NTC must have a dedicated interconnection tem to put the general outlines of the interconnection specifications

3.2. Analysis of the existing Technical Interconnection between Sudatel and Mobitel

3.2.1 Information and Data

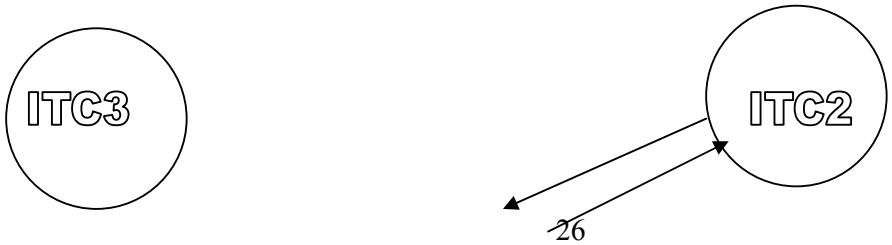
The existing configuration of Interconnection between Sudatel and Mobitel is schematically presented in Fig (3.1) while Table (3.1) shows the numbers of trunks.

Table 3.1 Existing Number of Trunks between Sudatel and Mobitel

Dest. I/C ↓ Orig. O/G →	TSC 1	TCS 2	ITC3	ITC2 (INT)	ITC2 (NAT)	OMD	KHC	KHN	KHS	MED	PSD
TSC1	-	-	307 O/G	340 O/G	526 O/G	869 B/W	1052 B/W	62 B/W	1048 B/W	521 B/W	209 B/W
TSC2	-	-	-	-	-	803 B/W	62 B/W	568 B/W	30 B/W	-	-
ITC3	712 O/G	-	-	-	-	-	-	-	-	-	-
ITC2(INT)	433 O/G	-	-	-	-	-	-	-	-	-	-
ITC2(NAT)	930 O/G	-	-	-	-	-	-	-	-	-	-
OMD	-	-	-	-	-	-	-	-	-	-	-
KHC	-	-	-	-	-	-	-	-	-	-	-
KHN	-	-	-	-	-	-	-	-	-	-	-
KHS	-	-	-	-	-	-	-	-	-	-	-
MED	-	-	-	-	-	-	-	-	-	-	-
PSD	-	-	-	-	-	-	-	-	-	-	-

Source: Sudatel Traffic Data

TSC1&TSC2----Mobitel Gateway switches at Khartoum centre
ITC3-----Sudatel International Switch at Um Haraz
ITC2 ----Sudatel International Switch at Khartoum centre
KHC-----Khartoum centre Local/ Transit Switch
KHN-----Khartoum North Local/ Transit Switch
KHS-----Khartoum South Local/ Transit Switch
OMD----Omdruman Local/ Transit Switch
PSD-----Port Sudan National Switch
MED----Medani National Switch
INT----- International Traffic
NAT---- National Traffic
O/G---- Outgoing & I/C-----Incoming & B/W---- Both way
Dest --- Destination &Orig. ----Origination [5]



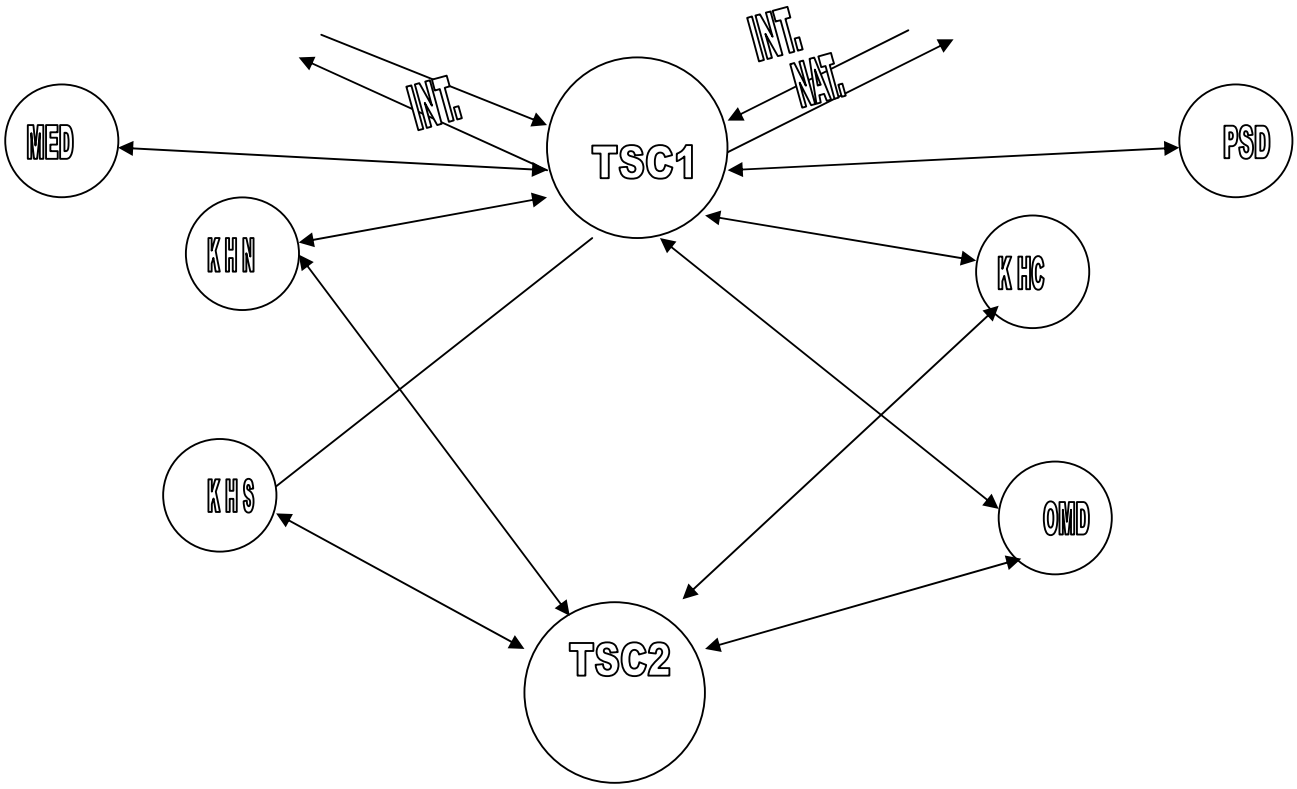


Figure (3.1) Existing Links between Sudatel & Mobitel [5]

INT----- International Traffic
NAT---- National Traffic

From figure (3.1):

For Mobitel there are two Gateway Switches TSC1 and TSC2

For Sudatel there are many routes to Mobitel:

- Two routes for the International Switches (ITC2 and ITC3)
- Four routes for the local/ transit Switches (OMD, KHC,KHN, KHS)
- One direct route to the National Switches (PSD)
- One common route for the other National traffic, which is connected to the International Switch ITC2

As seen from the figure (3.1) the interconnection level is only at the international, national and transit levels. There is no direct link at the local level. Also for the national not all Sudatel National Switches has a direct route to Mobitel, the traffic to and from them routed via ITC2.
Also no redundancy for the International traffic in the side of Mobitel
Some of routes are uni-directional routes (one route for the outgoing traffic and the other for the incoming traffic) and the other has both way routes as seen from figure (1).

For further analysis of the Interconnection problems between Sudatel and Mobitel, the study should put emphasis on Six Interconnection links:

1-The link between the international Switch ITC3, which is located at Um Haraz (outgoing and incoming in different routes)

2-The link between the international Switch ITC2, which is located at Khartoum centre city (outgoing and incoming in different routes)

3-The two link's between Omdurman transit Switch and Mobitel which is located at Omdurman city.(both way)

4-The National link between ITC2 and Mobitel, which is located at Khartoum centre city (outgoing and incoming in different routes)

5-The National link between Port Sudan and Mobitel, which is located at Port Sudan city (both way)

At the first to study the technical problems we collected row data from the Switches and analysis it by using some Excels active sheet and from that analysis.

The Tables (3.1up to 3.6) shows the Traffic information and average percentage of the faults. [5]

Table 3.2 International Traffic data and performance for International Switch (ITC3)

Period (Wed 01/01/2005 To: Thu 30/06/2005)				
INCOMING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total Incoming Calls	12,506	194,082	5,234,470	32,395,767
Total Incoming Traffic (Minutes)	9,345	136,590	3,984,773	19,915,880
Total Incoming Carried Traffic (Erlang)	82	12,156	350,510	1,799,922
Answered Incoming Calls	2,942	4,961	138,543	780,725
Lost Incoming Calls	9,564	144,474	3,849,042	24,588,519
Answered / Total Incoming Calls	**24%**	**26%**	**26%**	**24%**
OUTGOING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total Outgoing Calls	60,943	429,440	12,841,449	70,227,509
Total Outgoing Traffic (Minutes)	27,893	351,356	11,084,483	60,697,386
Total Outgoing Carried Traffic (Erlang)	234	2,916	92,664	503,551
Answered Outgoing Calls	7,700	110,714	3,457,913	19,061,456
Lost Outgoing Calls	53,243	318,726	9,383,536	51,166,053
Answered / Total Outgoing Calls	**13%**	**26%**	**27%**	**27%**
Lost Outgoing Calls due to Customer behaviour	15,321	217,596	7,305,875	38,052,418
Busy	2,377	30,825	1,007,615	5,388,629
Unanswered	12,889	185,686	6,254,021	32,453,256
Unallocated Number	40	848	37,338	173,665
Incomplete Number	15	237	6,901	36,868
Customer Behaviour / Total Outgoing	**25%**	**51%**	**57%**	**54%**
Lost Outgoing due to Network Performance	37,916	101,093	2,077,230	13,112,900
Congestion	643	4,706	162,919	788,713
Trunks busy	31,892	65,633	670,676	4,804,233
Trunks blocked	-	-	71	978
SS7 Failure	742	12,216	449,641	2,396,276
Technical Irregular	4,639	18,538	793,923	5,122,700
Network Performance / Total Outgoing	**62%**	**24%**	**16%**	**19%**
Total Connected Through Calls	29,045	363,770	12,170,271	65,421,563
ASR	**27%**	**30%**	**28%**	**29%**
Offered Traffic (Erlang)	491.9	344	9,777	54,054

Source: Sudatel Traffic Data

Table 3.3 International Traffic Data and Performance for

International Switch (ITC2)				
Period (Wed 01/01/2005 To: Thu 30/06/2005)				
Incoming	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total traffic (Minutes)	6,611	518,544	1,897,258	13,027,205
Total Incoming Calls	11,666	741,653	3,030,667	21,188,216
Number of Answered Calls	2,433	183,069	692,272	5,107,305
Answer/ Total Incoming Calls	**20.9**	**24.7**	**22.8**	**24.1**
Number Of Sub. Busy Calls	575	44,496	169,668	1,544,587
Number Of Unanswered Calls	4,916	304,714	1,191,036	8,176,542
Lost Calls due to Customer Behaviour	5,491	349,210	1,360,704	9,721,129
Customer Behaviour/Total Incoming calls	**47.1**	**47.1**	**44.9**	**45.9**
Signalling Failure	1,029	45,354	308,698	2,006,791
Technical failure	1,354	78,445	278,114	1,696,396
Trunk busy	104	2,667	10,695	108,884
Congestion	356	32,167	169,530	1,049,904
Wrong (Number or routing)	255	15,724	62,145	418,698
Wrong (Number or routing) distance	625	35,199	149,130	1,090,913
Lost Calls due to Network Performance	3,723	209,556	978,312	6,371,586
Network /Total Incoming calls	**31.9**	**28.3**	**32.3**	**30.1**
Outgoing	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total traffic (Minutes)	18,707	1,556,352	6,690,600	36,694,858
Total outgoing Calls	26,618	2,438,034	9,171,518	50,111,344
Number of Answered Calls	5,934	488,476	2,127,162	11,546,322
Answer/ Total Outgoing Calls	**22.3**	**20.0**	**23.2**	**23.0**
Sub. Busy Calls	2,285	139,274	611,894	3,249,133
Unanswered Calls	14,726	1,020,882	4,553,635	24,393,070
Lost Calls due to Customer Behaviours	17,011	1,160,156	5,165,529	27,642,203
Customer Behaviours/Total outgoing calls	**63.9**	**47.6**	**56.3**	**55.2**
Signalling Failure	513	26,197	114,837	1,296,054
Technical failure	191	11,128	56,121	560,557
Trunk busy	2,874	744,204	1,670,433	8,849,073
Congestion	14	984	8,085	1,377,020
Wrong (Number or routing)	3	57	477	2,228
Wrong (Number or routing) distance	27	3,615	16,466	343,034
Lost Calls due to Network Performance	3,622	786,185	1,866,419	12,427,966
Network /Total outgoing calls	**13.6**	**32.2**	**20.4**	**24.8**

Source: Sudatel Traffic Data

Table 3.4 Local/Transit Traffic Data and Performance for Omdurman (First Route)

Period (Wed 01/01/2005 To: Thu 30/06/2005)

INCOMING	Busy Hour	1 Day	1Month	6 Month
Total Incoming Calls	14,097	149,973	1,002,489	4,472,367
Total Incoming Traffic (Minutes)	4,581	64,220	449,442	1,839,564
Total Incoming Carried Traffic (Erlang)	44	620	4,336	17,866
Answered Incoming Calls	2,765	44,762	302,844	1,244,410
Lost Incoming Calls	11,332	105,211	699,645	3,227,957
Answered / Total Incoming Calls	**20%**	**30%**	**30%**	**28%**
OUTGOING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total Outgoing Calls	49,118	636,077	4,640,693	18,409,510
Total Outgoing Traffic (Minutes)	26,303	356,717	2,427,792	10,045,140
Total Outgoing Carried Traffic (Erlang)	244	33,490	230,584	950,924
Answered Outgoing Calls	11,169	19,721	134,266	555,008
Lost Outgoing Calls	37,949	438,865	3,298,029	12,859,430
Answered / Total Outgoing Calls	**23%**	**31%**	**29%**	**30%**
Lost Outgoing Calls due to Customer behaviours	26,059	356,032	2,533,876	10,274,697
Busy	6,235	72,398	499,639	2,036,724
Unanswered	19,644	280,587	2,014,779	8,159,476
Unallocated Number	180	3,044	19,432	78,430
Incomplete Number	-	3	26	67
Customer Behaviours / Total Outgoing	**53%**	**56%**	**55%**	**56%**
Lost Outgoing to Network Performance	12,131	82,838	764,153	2,584,537
Congestion	888	7,054	114,599	255,682
Trunks busy	2	767	7,074	88,599
Trunks blocked	-	-	-	82
SS7 Failure	1,024	16,469	123,508	494,927
Technical Irregular	10,217	58,548	518,972	1,745,247
Network Performance / Total Outgoing	**25%**	**13%**	**16%**	**14%**
Total Connected Through Calls	49,357	635,315	4,633,619	18,320,633
ASR	**23%**	**31%**	**29%**	**30%**
Offered Traffic(Erlang)	244	3,353	23,094	95,554

Source: Sudatel Traffic Data

Table 3.5 Local/Transit Traffic Data and Performance for

Omdurman Switch (Second route)				
Period (Wed 01/01/2005 To: Thu 30/06/2005)				
INCOMING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total Incoming Calls	11,080	113,678	3,419,384	22,591,807
Total Incoming Traffic (Minutes)	3,617	48,440	1,397,513	11,953,120
Total Incoming Carried Traffic (Erlang)	34	466	13,566	110,660
Answered Incoming Calls	2,091	33,528	939,017	7,269,033
Lost Incoming Calls	8,989	80,150	2,480,367	15,322,774
Answered / Total Incoming Calls	**19%**	**29.5**	**27.5**	**32.2**
OUTGOING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total Outgoing Calls	45,794	561,617	16,307,149	112,850,876
Total Outgoing Traffic (Minutes)	24,252	314,124	8,844,858	54,692,844
Total Outgoing Carried Traffic (Erlang)	223	2,949	83,742	501,034
Answered Outgoing Calls	10,297	172,984	4,860,103	28,658,124
Lost Outgoing Calls	35,497	388,633	11,447,046	84,192,752
Answered / Total Outgoing Calls	**22%**	**31%**	**30%**	**25%**
Lost Outgoing Calls to Customer behaviours	**24,150**	313,916	9,095,836	50,651,972
Busy	5,847	64,153	1,800,194	10,275,184
Unanswered	18,166	247,208	7,230,850	40,009,741
Unallocated Number	**137**	2,554	64,737	366,647
Incomplete Number	**-**	1	55	400
Customer Behaviours / Total Outgoing	**53%**	**56%**	**56%**	**45%**
Lost Outgoing to network Performance	11,551	74,710	2,351,222	25,616,808
Congestion	600	3,827	121,717	631,312
Trunks busy	102	626	99,525	12,488,793
Trunks blocked	-	-	1,592	17,208
SS7 Failure	1,965	25,435	723,955	4,345,117
Technical Irregular	8,884	44,822	1,404,433	8,134,378
Network Performance / Total Outgoing	**25%**	**13%**	**14%**	**23%**
Total Connected Through Calls	45,896	16,206,042	92,420,901	560,984
ASR	**22%**	**31%**	**30%**	**31%**
Offered Traffic(Erlang)	223	2,952	84,265	611,789

Source: Sudatel Traffic Data

Table3.6 National Traffic Data and Performance for

International Switch (ITC2				
Period (Wed 01/01/2005 To: Thu 30/06/2005)				
INCOMING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total traffic (Minutes)	22,192	278,568	8,205,163	52,097,875
Total Incoming Calls	30,239	576,125	22,965,180	125,311,998
Number of Answered Calls	9,425	154,187	4,428,892	27,585,994
Answer/ Total Incoming Calls	**31.2**	**26.8**	**19.3**	**22.0**
Number Of Sub. Busy Calls	5,956	136,911	4,066,921	23,101,544
Number Of Unanswered Calls	6,651	142,680	4,485,958	25,757,008
Lost Calls due to Customer Behaviour	12,607	279,591	8,552,879	48,858,552
Customer Behaviour/Total Incoming calls	**41.7**	**48.5**	**37.2**	**39.0**
Signalling Failure	2,883	25,972	1,076,870	4,013,009
Technical failure	2,330	81,217	2,797,849	18,614,965
Trunk busy	10,774	45,171	6,016,757	22,854,822
Congestion	479	9,692	905,685	4,549,015
Wrong (Number or routing)	49	2,094	65,367	782,379
Wrong (Number or routing) distance	303	7,796	334,547	1,917,589
Lost Calls due to Network Performance	16,818	171,942	11,197,075	52,731,779
Network /Total Incoming calls	**55.6**	**29.8**	**48.8**	**42.1**
Outgoing	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total traffic (Minutes)	39,346	506,880	14,425,402	76,030,142
Total outgoing Calls	471,304	2,447,712	66,537,155	275,093,593
Number of Answered Calls	16,531	249,019	7,084,338	37,526,069
Answer/ Total Outgoing Calls	**3.5**	**10.2**	**10.6**	**13.6**
Sub. Busy Calls	4,716	95,205	2,735,346	14,971,827
Unanswered Calls	38,087	550,595	16,833,493	89,399,999
Lost Calls due to Customer Behaviours	42,803	645,800	19,568,839	104,371,826
Customer Behaviours/Total outgoing calls	**9.1**	**26.4**	**29.4**	**37.9**
Signalling Failure	1,783	35,786	937,925	6,239,518
Technical failure	352	10,191	287,209	2,993,445
Trunk busy	408,117	1,490,822	38,153,416	119,833,981
Congestion	23	277	10,190	932,809
Wrong (Number or routing)	13	131	4,015	19,570
Wrong(Number or routing) distance	384	9,102	278,932	1,548,660
Lost Calls due to Network Performance	410,672	1,546,309	39,671,687	131,567,983
Network /Total outgoing calls	**87.1**	**63.2**	**59.6**	**47.8**

Source: Sudatel Traffic Data

Table 3.7 National Traffic Data and Performance for National link (PSD) Switch				
Period (Wed 01/01/2005 To: Thu 30/06/2005)				
INCOMING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total Incoming Calls	4,485	58,209	1,694,153	9,191,050
Total Incoming Traffic (Minutes)	2,312	29,855	852,058	4,708,151
Total Incoming Carried Traffic (Erlang)	20	274	7,853	43,418
Answered Incoming Calls	1,281	19,831	555,198	3,036,458
Lost Incoming Calls	3,204	38,378	1,138,955	6,154,592
Answered / Total Incoming Calls	**29%**	**34%**	**33%**	**33%**
OUTGOING	**Busy Hour**	**1 Day**	**1Month**	**6 Month**
Total Outgoing Calls	17,007	290,218	9,322,044	44,293,861
Total Outgoing Traffic (Minutes)	6,156	91,688	2,578,104	13,534,422
Total Outgoing Carried Traffic (Erlang)	58	8,727	246,394	1,349,596
Answered Outgoing Calls	2,654	46,875	1,305,802	7,039,458
Lost Outgoing Calls	14,353	243,343	8,016,242	37,254,403
Answered / Total Outgoing Calls	**16%**	**16%**	**14%**	**16%**
Lost Outgoing Calls due to Customer behaviours	7,065	109,929	3,189,582	17,421,934
Busy	1,536	20,170	593,350	3,270,459
Unanswered	5,473	89,098	2,578,553	14,051,518
Unallocated Number	56	661	17,671	99,923
Incomplete Number	-	-	8	34
Customer Behaviours / Total Outgoing	**42%**	**38%**	**34%**	**39%**
Lost Outgoing due to Network Performance	7,327	133,412	4,826,617	19,832,414
Congestion	352	5,489	241,705	1,276,494
Trunks busy	5,158	111,902	3,989,691	13,210,519
Trunks blocked	-	-	88,431	88,453
SS7 Failure	212	3,772	107,886	1,795,909
Technical Irregular	1,605	12,249	398,904	3,461,039
Network Performance / Total Outgoing	**43%**	**46%**	**52%**	**45%**
Total Connected Through Calls	11,888	178,314	5,243,879	30,994,834
ASR	**22%**	**26%**	**25%**	**23%**
Offered Traffic(Erlang)	83.0	1,420	43,802	192,867

Source: Sudatel Traffic Data

3.2.2 Data Analysis

From the above tables we can identify that the reasons for the failed calls may be categorised in two groups:

- Network performance
- Subscriber behaviour

3.2.2.1 Problems Due to Network Performance

From the above Tables the number of calls failed due to the network performance is high and this due to technical problems

From table 3.2 up table 3.7 the average percentages of the network performance for the six routes are as follows:

ITC3 (International) is 19%
ITC2 (International) is 25%
MOB1SB (the first route Omdurman) is 29%
MBT1SB (the other route to Omdurman) is 23%
ITC2 (national) is 42.1%
PSD is 45%

The average percentages for the national routes are higher than the other routes

Also the average percentages of the network performance those for the same route but in different time (one day, one week, one month and six month) is nearly the same this indicates that no Improvement in the network within long time.

As seen from the table below the numbers of the Calls which failed due to the network Performance is very high, no Technical Interconnection specification is applied, and no one of the two parties take care about solving these problems when they happen or in the early stage of the implementation, no sufficient test, the compatibility test is not complete as the standard procedure and so on.

In the following tables more analysis of the technical problems are given

A. Traffic Data for Outgoing Traffic from Sudatel to Mobitel

Period (1/1/2005 to 30/06/2005)

The details of data for the outgoing traffic is available in all Switches

Table 3.8 International Switch ITC3 (international traffic data)*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	70,227,509	
Congestion	788,713	1.1%
Trunk Busy	4,804,233	6.8%
Signaling problems	7,518,976	10.7%
Wrong Numbers or routing	210,533	.3%
As average percentage of total outgoing calls	**13,322,465**	**19.0%**

* Data is taken from table 3.2 above

Table 3.9 International Switches ITC2 (International Traffic

Data)*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	50,111,344	
Congestion	1,377,020	2.7%
Trunk Busy	8,849,073	17.6%
Signaling problems	1,296,054	2.6%
Other technical problems	560,557	1.16%
Wrong Numbers or routing	345,262	.7%
As average percentage of total outgoing calls	**12,427,966**	**24.8**

* Data is taken from table 3.3 above

Table 3.10 Traffic Data for Local/Transit Switch Omdurman (First Route)*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	132,520,898	
Congestion	1,396,980	1.1%
Trunk Busy	21,449,462	16.2%
Signaling problems	15,081,282	11.4%
Wrong Numbers or routing	451,461	.34%
As average percentage of total outgoing calls	**38,379,185**	**29.0%**

* Data is taken from table 3.4 above

Table 3.11 Local/Transit Switch Omdurman (local/Transit Traffic Data) Second Route*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	112,850,876	
Congestion	631,312	.6%
Trunk Busy	12,506,001	11.1%
Signaling problems	12,479,495	11.1%
Wrong Numbers or routing	367,047	.3%
As average percentage of total outgoing calls	**25,983,855**	**23.0%**

* Data is taken from table 3.5 above

Table 3.12 International Switch ITC2 (National Traffic Data)*		
Outgoing traffic from Sudatel to	**Numbers of calls**	**Percentage (%)**

Mobitel		
Total outgoing calls	275,093,593	.
Congestion	932,809	.3%
Trunk Busy	119,833,981	43.6%
Signaling problems	6,239,518	2.3%
Other technical problems	2,993,445	1.0%
Wrong Numbers or routing	1,568,230	.6%
As average percentage of total outgoing calls	**131,567,983**	**47.8%**

* Data is taken from table 3.6 above

Table 3.13 National Switches PSD (National Traffic Data)*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	44,293,861	
Congestion	1,276,494	2.9%
Trunk Busy	13,298,972	30.0%
Signaling problems	5,256,948	12.0%
Wrong Numbers or routing	99,957	.2%
As average percentage of total outgoing calls	**33,983,855**	**45%**

* Data is taken from table 3.7 above

B. Incoming Traffic Data from Mobitel to Sudatel

Period (1/1/2005 to 30/06/2005)

The details data for the outgoing traffic is available only on ITC2 Switch

Table 3.14 International Switch ITC2 (International Traffic)*		
Incoming traffic from Mobitel to Sudatel	**Numbers of calls**	**Percentage (%)**
Total Incoming calls	21,188,216	
Congestion	1,049,904	5.0%
Trunk Busy	108,884	.51%
Signalling problems	2,006,791	9.5%
Other technical problems	1,696,396	8.0%
Wrong Numbers or routing	1,509,611	7.1%
As average percentage of total incoming calls	**6,371,586**	**30.1%**

* Data is taken from table 3.3

Table 3.15 International Switches ITC2 (National Traffic)*		
Incoming traffic from	**Numbers of calls**	**Percentage (%)**

Mobitel to Sudatel		
Total Incoming calls	125,311,998	
Congestion	4,549,015	3.6%
Trunk Busy	22,854,822	18.2%
Signaling problems	4,013,009	3.2%
Other technical problems	18,614,965	14.9%
Wrong Numbers or routing	2,699,968	2.1%
As average percentage of Total incoming calls	**52,731,779**	**42.0%**

* Data is taken from table 3.6

3.2.2.2 Problems Appearing as Subscriber Behaviour

The following tables show the failed Calls due to subscribers' behaviour. These tables are very important because it partly reflect the network technical problems, which appear as subscriber "busy" or "no answer", in case of Sudatel. In case of Mobitel, the miss call appears as "no answer". These technical problems need to be addressed in combination with consumer awareness program in order to assure the efficient use of the system.
The average percentages of the faults due to Subscriber Behaviour,
For Six routes, are as follows:

A. Outgoing Traffic from Sudatel to Mobitel

Period (1/1/2005 to 30/06/2005)

Table 3.16 International Switches ITC2*		
Incoming traffic from Mobitel to Sudatel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	70,227,509	
Subscriber busy	5,388,629	7.8%
No answer	32,453,256	46.2%
As average percentage of Total outgoing calls	**37,841,885**	**53.9%**

* Data is taken from table 3.2 above

Table 3.17 International Switches ITC2*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of Calls**	**Percentage (%)**
Total outgoing calls	50,111,344	
Subscriber busy	3,249,133	6.5%
No answer	24,393,070	48.7%
As average percentage of Total outgoing calls	**27,642,203**	**55.2%**

* Data is taken from table 3.3 above

Table 3.18 Local/Transit Switch Omdurman (First Route)*

Outgoing traffic from Sudatel to Mobitel	Numbers of Calls	Percentage (%)
Total outgoing calls	132,520,898	
Subscriber busy	11,894,478	9.0%
No answer	46,825,106	35.3%
As average percentage of Total outgoing calls	**58,719,584**	**44.3%**

* Data is taken from table 3.4 above

Table 3.19 Local/Transit Switch Omdurman (Second Route)*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	112,850,876	
Subscriber busy	10,275,184	9.1%
No answer	40,009,741	35.5%
As average percentage of Total outgoing calls	**50,284,925**	**44.6%**

* Data is taken from table 3.5 above

Table 3.20 International Switch ITC2 (National Traffic)*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of Calls**	**Percentage (%)**
Total outgoing calls	275,093,593	
Subscriber busy	14,971,827	5.4%
No answer	89,399,999	32.5%
As average percentage of total outgoing calls	**104,371,826**	**37.9%**

* Data is taken from table 3.6 above

Table 3.21 National Switches PSD*		
Outgoing traffic from Sudatel to Mobitel	**Numbers of calls**	**Percentage (%)**
Total outgoing calls	44,293,861	
Subscriber busy	3,270,459	7.9%
No answer	14,051,518	31.7%
As average percentage of total outgoing calls	**17,321,977**	**39.1%**

* Data is taken from table 3.7 above

B. Data for Incoming Traffic from Mobitel to Sudatel

Period (1/1/2005 to 30/06/2005)
The details data for the incoming traffic the details data is only in International Switch ITC2 (International and National)

Table 3.22 International Switches ITC2 (International Traffic)*		
Incoming traffic from Mobitel to Sudatel	**Numbers of calls**	**Percentage (%)**
Total Incoming calls	21,188,216	
Subscriber busy	1,544,587	7.3%
No answer	8,176,542	38.6%
As average percentage of Total incoming calls	**9,721,129**	**45.9%**

* Data is taken from table 3.3 above

Table 3.23 International Switches ITC2 (National Traffic)*		
Incoming traffic from Mobitel to Sudatel	**Numbers of calls**	**Percentage (%)**
Total Incoming calls	125,311,998	
Subscriber busy	23,101,544	18.4%
No answer	25,757,008	20.6%
As average percentage of total incoming calls	**48,858,552**	**39.0%**

* Data is taken from table 3.6 above

3.2.3 Data Interpretation and Analysis

The collected data and information on the actual existing network has to be compared with the others interconnection agreements in order to discover the shortcomings and propose solutions.

3.2.3.1 Point of Interconnect and Interconnect link

A. Network level

The existing point of interconnect is at the level of:

- International
- National and Local/Transit

There is no Interconnection in the level of the local Switches despite of the traffic between Mobitel and some of Sudatel local Switches is more than the traffic between Mobitel and the transit Switches, so they must be direct links between Mobitel and some of the Sudatel local Switch with heavy traffic.

Examples:

Table 3.24 Traffic from Omdurman To Mobitel*	
Destination	**Minutes**
Omdurman (Local)	11,153,391
Mahdia ((Local)	7,330,297
Umbada (Local)	7,099,207
Abu Seed (Local)	3,914,985
Total Omdurman (Local/Transit)	29,497,881

* Period (1/1/2005--------30/06/2005)

As seen from the table above the traffic from Mahdia and Umbada (local Switches) to Mobitel is nearly the traffic from Omudrman local Switch to Mobitel
So they must be direct route from Mahdia and Umbada to Mobitel.
Also for the National only Medni and Portsudan have a direct route to Mobitel the traffic from the other National Switches (Nyala, kassala, Atbara, Elobed and Joba)
Are routed via ITC2, some of this national Switches have high Traffic and must also have direct route to Mobitel according to the amount of traffic.
Or Sudatel can implement Interconnection Switch (Gateway Switch) and the International, National, Transit and Local traffic to and from Mobitel are connected to this Interconnection Switch depends on the traffic forecast, then the traffic from this Interconnection Switch is connected to both Mobitel two gateway Switch (TSC1and TSC2) for redundancy.
The configuration must be review and after the negotiation and agreement between the two parties the correct configuration must be implemented
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions

B. Location of the POI

All locations of points is at Sudatel sites and this is compatible with one of the three proposed location in the international interconnection agreements, the access for routine and maintenance is now easily, also for the electrical power that provide it and under what condition.
There is no written agreement between the two parties to provide such service.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to the international agreements specifications

C. Interconnect Link

Interconnect Link will be established between the two parties to provide the means by which calls and signaling can be based between the two network

3.2.3.2 Interface Standards

There are three types of interface standards, namely:

A. Physical Interface

The existing physical interface between Sudatel and Mobitel using the Optical Fibre media and this is standard.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions

B. Transmission Interface

Both parties are using the Synchronous Digital Hierarchy (SDH) and this is standards and also compatible with international agreements specifications
The interconnection bandwidth between the two parties is at 2M/B level. They must use the high level by using (Multiplexing and Demultiplexing)
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions

C. Signalling Interface

The two parties are using SS No 7 as their signalling protocol
There are many signalling problems arising because no Signalling survey has been taken before the first implementation of the Interconnect link, and the signalling is not compatible between the parties, and the existing signalling not completely standards, also in some routes there is only one signalling links and they must be another link for redundancy, the numbers of Signalling link must depend on the amount of the traffic, also any faults on the signalling must take priority on the maintenance
From the tables below the average percentages of calls which failed due to signalling problems is high depend on the types of switches.

Table 3.25 Outgoing Traffic Data From Sudatel To Mobitel*

Outgoing traffic from Sudatel to Mobitel	Total Calls	Failed Calls due to signalling	Percentages
ITC3	70,227,509	7,518,976	10.7%
ITC2 (International)	50,111,344	1,296,054	2.7%
MBT1SB	112,850,876	12,479,495	11.1%
MOB1Sb	132,520,898	15,081,282	11.4%
ITC2 (national)	275,093,593	6,239,518	2.3%
PSD	44,293,861	5,256,948	11.9%
As average percentage of total outgoing calls	**685,098,081**	**47,872,273**	**7.0%**

*Data is taken from table 3.2 to table 3.7 above

Table 3.26 Incoming Traffic Data From Mobitel To Sudatel*			
Incoming traffic from Mobitel to Sudatel	**Total calls**	**Failed Calls due to signalling**	**Percentages**
ITC2 (International)	21,188,216	2,006,791	9.5%
ITC2 (national)	52,097,875	4,013,009	7.7%
As average percentage of total incoming calls	**73,286,091**	**6,019,800**	**8.2%**

*Data is taken from table 3.3 and table 3.6 above

Sudatel switches from different company (Alcatel, Ericsons Siemens and other small switches). While Mobitel switches from Ericsons, this will lead to signalling incompatibility when this company not using the standard specifications.
As seen from the table the average percentages of the Calls failed due to the signalling is different from one switch to the other, for the International traffic the problems are small compare with the Transit and national.
The signalling parameters must be tested and all incompatible parameters must be check and solved due to ITU Standards:
ITU Rec. Q703
ITU Rec. Q761---766
Also more than one signaling links (depends in the traffic) must be used and they must be alternative signaling routes .The number of signaling links is depends on the traffic, also the signaling transfer point must be used if the amount of traffic not large (no need for signaling link)
The signaling survey must be done before the new implementation
The ITU recommendation, which must used in the signaling, must clearly specified in the agreement
There is no written agreement between the two parties concerning the signalling
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions

3.2.3.3 Network Synchronization

Table 3.27 Show The Failed Calls Due To Synchronization*			
Outgoing traffic from Sudatel to Mobitel	**Total calls**	**Failed Calls due to Synchronization**	**Percentages**
ITC2 (International)	42,897,428	7,951	.02%
ITC2 (national)	153,941,360	11,472	.007%
As average percentage of total outgoing calls	**196,838,788**	**19,423**	**.009%**

*Data is taken from table 3.3 and table 3.6 above

Because Sudatel and Mobitel using synchronous digital hierarchy (SDH), so synchronization must be Important to avoid the problems coming from poor synchronization. But the networks for both Sudatel and Mobitel are not well synchronized, and so they are some problems and must be resolved by the interconnection agreements.

The two parties can agree to use the same type and source of synchronization due to special agreement for synchronization.
There is no written agreement between the two parties concerning the synchronization.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.4 Services

Interconnect services are provided in order to allow customers connected to operator's network to access services offered by another operator, possibly in competition with first operator. Furthermore, some interconnect services may be provided by an operator on a fully competitive basis as alternative to other ways of meeting demands.
The following is not an exhaustive list of services. For each service in the interconnect agreement, principle of charging and call handover shall be defined.
All the following points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

A. Data Management Amendments

Access to each other's telephone numbers will be achieved by implementing data management amendment in the networks.
This is not completely implemented in the two company, no feedback about the correct data which implemented in both sides, and due to wrong data may lead to wrong numbering or routing as seen from the tables, so there must be done to verifying the correct data was implemented and the data must be Corrected from time to time and there must be a feedback from each company, also the new data must inter as soon as implemented in any site.
There is no written agreement between the two parties to provide such service and must included in details in the agreement

B. Conveyance

The subject of telecommunication is the conveyance.
For local, national, international, transit, special telephone service and access to local loop.
In the existing situation, the technical problems between the two parties affect the Conveyance especially the part of congestion and trunks busy, wrong routing, signalling faults and problems and all other technical problems must be solved to make good conveyance.
There is no written agreement between the two parties concerning the conveyance and must included in details in the agreement

C. Operator Assistance Services

The call will be passed over to the operator assistance service at a number of specified connection points.
There is no written agreement between the two parties to provide such service and must included in details in the agreement

D. Directory Enquiry Services

The call will be passed over to the directory enquiry provider, at a number of specified connection points.
There is no written agreement between the two parties to provide such service and must included in details in the agreement

E. Emergency Services

Customers of all operators can pass their customers emergency services Calls to the emergency service provider and then handed and pass to correct authorities, its very important service.
There is no written agreement between the two parties to provide such service and must included in details in the agreement

F. Numbers Information System Services

The numbers of all operators must be allowed in a numbers information system database. It is source of phone books and directory assistance information.
There is no written agreement between the two parties to provide such service and must included in details in the agreement

G. Phonebook and Directory listing

The operators buy directories from the providing operator, for distribution to their customers; nothing in the Interconnection agreement shall be read to require an operator to have a printed directory.
There is no written agreement between the two parties to provide such service and may or may not included in details in the agreement

H. Calling Card/Charge Card Facilities

This will enable all operators to provide their customers with access to another operator's charge card platform to enable calls to be made and charged to the calling card/charge card.
There is no written agreement between the two parties to provide such service and must included in details in the agreement

I. Numbers Portability

There are two types of number portability:

- Operator Portability
- Geographical Portability

The availability of numbers Portability, especially operator Portability, is imperative to the introduction of competition in telecommunication and these services shall thus be made available at the earliest possible time.
There are no such services now implemented in both parties and this is very important Services and must be included in details in the written agreement for both the operator and geographic portability.

J. Access Service

There are two type of access Services:

- Indirect Access
- Carrier Pre-Selection

Access is general service provided by the operator serving the calling customer. Operator A providing the physical connection to the other party operator (B), enabling the calling customer to access services offered by Operator (B).
There is no written agreement between the two parties to provide such service and must included in details in the agreement.

K. ISDN/GSM Supplementary Services

There are three types of ISDN/GSM Services:

- End to end ISDN supplementary services between fixed networks
- End to End GSM supplementary services
- Common ISDN/GSM supplementary services between a fixed and a mobile network

There is no written agreement between the two parties to provide such service and must included in details in the agreement,

L. Access to Service Providers

For new service introduced by a third party operator, or service provider, where the operator with significant market power is usually the first to be able to reach commercial agreement for access an issue to consider is interconnect access to a transit service offered by the operator with significant market power to access the new service of the relevant third partly.
There is no written agreement between the two parties to provide such service and must included in details in the written agreement

M. Advanced Services

- VPN services
- IN advanced services (Free phone, premium rate, virtual calling card, UPT)

There is no written agreement between the two parties to provide such service and must included in details in the written agreement

3.2.3.5 Intelligent Network Interconnection (IN)

This section deals with the Interconnection of advanced services such as cash less calling, Call forwarding, Credit card calling, Prepaid calling card, Prepaid account telephony, numbers portability, Universal Access Distribution, Universal personal numbers, Wake up service, Conference, Voice mail**,** etc.
Not all this advanced services implemented in both parties, but all company must try to follow the new technologies an implement all the new services.
There is no written agreement between the two parties to provide such intelligent service and must be a subject of negotiation between the two parties and later included, in detail, in a written agreement, according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.6 Numbering

The allocation of numbers is matter for the National Regulatory Authority (NTC**).**
All subscribers numbering must implemented in both parties in the Switches data base and also the new numbering and the numbering modification, also shot access code, signalling point code.
Also test must be done to insure that numbering is implemented correctly, this is for local, national and international numbering, now there are many problems coming from the wrong numbering.
In the absent of the agreement no one care to follow the above points concerning the numbering.
There is no written agreement between the two parties to do this service, the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement, according to other's international interconnection specifications and conditions, and NTC conditions

3.2.3.7 Calling line Identification (CLI)

This section shall define condition under which an operator will convey CLI to another operator.
This is very important especially for signaling, billing and call routing, display and validation, and must be free use of CLI for the purposes of signalling and billing, must be implemented in good way.
There is no written agreement between the two parties to provide this service as the international interconnection agreement specifications,the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement ,according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.8 Quality of Services

There are three types of QoS:

- Telephony
- Interconnect links
- data management

This section shall define the Quality of Service parameters that each party shall meet, the way to measure the actual performance and the consequences of not meeting the agreed figures.
Quality of service provision shall be in the agreement, stating a minimum standard service that is applied to the operators.
For protection alternative routing shall be available in the event of equipment failure.
Each operator must follow the ITU standard for quality of services ITU-T
All the following technical problems must solved to improved the quality of services: congestion between the two operators and within each party network, trunk blocked, DSN blocked, Wrong numbering, wrong routing, clash Signaling failure and Signaling incompatibility, bad synchronization, implementation of wrong data management and all other Switching and Transsimision problems that
Customers will be complains about the bad services.
There is no written agreement between the two parties to improved the quality of services as the international interconnection agreement specifications.the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.9 Network Design

Operators shall switch the configuration about its network to the extent necessary to perform network planning and planning of POIs. This includes a full listing of the Switches and associated numbers ranges where physical network Interconnection is used, the addresses of POIs.
Also the call routing, signalling routing and Information must be included.
In the existing situation this is not done correctly because there are:
There is no written agreement to force any party to give details Information about his network.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement, according t to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.10 Network Planning

This section shall define principals for the continuous planning process that must take place between the interconnecting parties. The planning process shall include:
New services, new POI, new Transsimision equipments, new Switching, new charging, new numbering, new software, new routing, signalling point code, or any changing in the above services, also the time scale must clearly specified,
In the existing situation no one of the two parties provides the other party with their network planning, there is no written agreement between the two parties.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.11 Forecasting

The parties must forecasts the amount of traffic expected over all interconnect links, based on this forecasts and the QOS requirements the capacity for the different routes shall be planned. They must be sufficient time for forecasts capacity to be implemented (6 month or more) depend on the agreement forecasts delivery time, and forecast must be reasonable and for the real demand.
This does not exist now, and each one of the parties may suddenly decide to add more circuit and make a request and try to force the other party to agree to add more circuit or new links.
As seen from the tables there is no real forecast, every time there are congestion between the two party, and also the Internal congestion in Mobitel Network (in the Base Station) and Sudatel internal network (between Sudatel Switches).
See tables (8.1 and 8.2) for the congestion and table (8.3 and 8.4) for the trunk busy, (trunk busy means the congestion in the direct route and congestion means in the internal network).
Also the forecasting must not be more than the actual need, If the actual usage of the interconnect capacity must be greater than or equal to ninety (**90**) **%** of its forecast, no over forecasting charges shall apply. If the actual usage is less than ninety (**90**) **%** the requested party shall pay for the unused capacity.

Tables below show failed Calls due to Congestion

Table 3.28 Outgoing from Sudatel to Mobitel*

Outgoing traffic from Sudatel to Mobitel	Total calls	Failed Calls due to Congestion	Percentages
ITC3	70,227,509	788,713	1.1%
ITC2(International)	50,111,344	1,377,020	2.7%
MBT1SB	112,850,876	631,312	.6%
MOB1Sb	132,520,898	1,396,980	1.1%
ITC2(national)	275,093,593	932,809	.3%
PSD	44,293,861	12,769,494	28.8%
As average percentage of total outgoing calls	**685,098,081**	**17,896,328**	**2.6%**

* Data taken from tables (3.2) to (3.7)

Table 3.29 Incoming from Mobitel to Sudatel*

Incoming traffic from Mobitel to Sudatel	Total calls	Failed Calls due to Congestion	Percentages
ITC2 (International)	21,188,216	1,049,904	5.0%
ITC2 (national)	52,097,875	4,549,015	8.7%
As average percentage of total incoming calls	**73,286,091**	**5,598,919**	**7.6%**

* Data taken from tables (3.3) and (3.6)

Tables below shows failed Calls due to Trunk busy

Table 3.30 Outgoing from Sudatel to Mobitel*			
Outgoing traffic from Sudatel to Mobitel	**Total calls**	**Failed Calls due to Trunk Busy**	**percentages**
ITC3	70,227,509	4,804,233	6.8%
ITC2(International)	50,111,344	8,849,073	17.7%
MBT1SB	112,850,876	21,449,462	19.0%
MOB1Sb	132,520,898	12,506,001	9.4%
ITC2(national)	275,093,593	119,833,500	43.6%
PSD	44,293,861	13,210,519	29.8%
As average percentage of total outgoing calls	**685,098,081**	**133,044,500**	**19.4%**

* Data taken from tables (3.2) to (3.7)

Table 3.31 Incoming from Mobitel to Sudate*			
Incoming traffic from Mobitel to Sudatel	**Total calls**	**Failed Calls due to Congestion**	**Percentages**
ITC2 (International)	21,188,216	108,884	.5%
ITC2 (national)	52,097,875	22,854,822	43.9%
As average percentage of total incoming calls	**73,286,091**	**22,963,706**	**31.3%**

* Data taken from tables (3.2) and (3.5)

In the existing situation the forecasting is not done as real traffic demand, There is no written agreements.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.12 Network Protection and Safety

Both parties must protect each other's network (by following the standards specification, proper testing and also must prevent endangering peoples.
The parties shall define their respective obligations to protect each other's networks and define measures to prevent endangering people.

A. Network Integrity

Network integrity is a question of network management and the ability of the network to maintain certain characteristics with regard to performance and reliability; these must be done by testing, compatibility measures following the national and international standards.

B. Operation

Each partly shall be reasonable for the safety and operation of its own system, there shall be points of contact and escalation procedure to guarantee a rapid, non-discriminatory response in case of faults in the operation of the other's party network.

C. Monitoring

Every network operator shall be informed at all times about the condition, status of his network and shall pass on relevant information to other interconnected operators in order to be able to identify and clear faults and overload rapidly.
Do not endanger the safety or health of any person, including the employees and contractors of other party and each party shall ensure that its network and operating procedures comply in all respects with this agreement.
They are many details concerning the above three points as seen from chapter two
In the existing situation there are protection& safety but not done properly as other's interconnection specifications, and There is no Written agreement between the two parties concerning this section.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to the international interconnection agreements.

3.2.3.13 Installation and Testing

The procedure of the installation and testing for the initial installation or expansion or upgrading must clearly specify between the parties. It shall also define the principles for continuous operation of the Interconnection, including network and traffic supervision, fault and disturbance reporting and fault recovery action.
The need for testing Interconnect hardware and software results from the common interest of both networks in maintaining network integrity, Testing also help to verify the interoperability of services as well as to ensure a reasonable quality of service and continuous service provision to the customer.
The purpose of the Interconnect testing is to provide reassurance the party's network can inter-work correctly.
The testing must done for the first time after the installation (POI's, Switching, transsimition, signalling) for the hardware and software, new services, at expansion, upgrading and changing in the existing network, also testing and monitor the performance of the network.

Types of SS No. 7 testing

- Validation or Conformity Testing
- Interworking or Interoperability testing (in a test network environment)
- Interoperability or stability testing (in the operational network)
- Commissioning Testing

All testing must done according to national/international specifications ITU/ETSI (REC.Q763, ITU-T Rec. Q764 and ITU-T Rec. Q767

In the existing situation, the installation and testing are not done as the international interconnection specifications and There is no Written agreements.

All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.14 Decommissioning

When one party decide to decommissioning any equipment must notify the other party with the reason and at sufficient time before the decommissioning except in the case of the emergency, the party may close or replace its SGS or a POI or decommissioning an interconnect link without prior written notice to the other party, provided that it notifies the other party as soon as practicable that the emergency event exists and that emergency relocation work is being or will be performed.
The decommissioning party shall bear all direct costs incurred by both parties in charring out the decommissioning except in the case of decommission due to emergency case according to he reason of this emergency fault.
In the existing situation the decommissioning is not done as international specifications and there are no written agreements.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.15 Operation and Maintenance

An operation and maintenance manual shall be drawn up by the parties detailing the responsibilities, methods, and the procedures for the operation and maintenance system at the required quality of service.
If either party identify a fault in its network may have an adverse effect on the other party's system, shall promptly inform the other party about the fault and the actions being taken to resolve the problem, the service restoration shall take priority over the clearance of faults not affecting service, also the fault must rectify as fast as possible and the party informed of progress on a regular basis.
Both parties shall co- operate in any investigation and follow up actions and keep each other informed on the status of the progress of the fault clearance .A 24 hour contact points must exist, also the operation and maintenance manual must exist.
There are many type of the fault: Transsimision, signalling, gateway switch fault and any fault in the local network, which may affect the traffic between the operators.
In the existing situation there are Operation and Maintenance but not done in a proper way as other's interconnection specifications and the fault clearing may take along time, and in most case no one of the party informed the other as soon as the fault arise, because this part is very important must be at the top of the negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.16 Change in the Network

When any parties decide to make change in its network and these change may be an impact on the system of the other operator must notify the other party before sufficient period of time, and must be reasonable for the direct cost of such change in the other

party's network, exception to this would be in case where the change is agreed or where the alteration is part of a planned upgrade program.

The change may be:

- Hardware and software changes
- Signalling and software upgrade

In the existing situation, no one of the two party inform the other about the change before sufficient period of time, and no reasonability for the direct cost of such change and fault.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.17 Provision of Information

This section shall for providing information about each party network (network structure and interfaces) also the planned changes to the network structure (transmission, switching, signalling), network hierarchy that may have impact on the other operators. The rules for providing information on the existing network must clearly identified, for the avoidance of doubt, the information that is proprietary, confidential or commercially sensitive must not be provided.
In the existing situation, no agreement between the two parties to provide each other with such information.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.18 New Request for Interconnection Services

This including the new services and also the expansion of the existing services
Any Interconnection service already provided
Any service already provided by an operator to itself
Any service not provided at all by the operator to whom the request is made
The parties shall negotiate in good faith and use efforts to reach agreement as soon as possible, within agreed time scales, after a request for interconnect has been accepted or is obligatory, if agreement is not reached temporary prices shall be applied, to prevent unnecessary delay to the launch of new services. These prices shall be retrospectively adjusted when the price is finally agreed or determined.
Now no written agreements
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.2.3.19 Implementation Time

Detailed contractual and non-contractual time scales must clearly defined, time scales may be dependent on the capacity ordered and the amount of associated planning. The expansion on existing routes must be provided more quickly than capacity on new routes, reasonable flexibility in capacity ordering shall be permitted in the early stages of planning anew Interconnection link, It is common and desirable for the operators to provide periodic forecasts of circuit requirements for Interconnect links, joint planning is necessary to ensure acceptable schedules quality.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

3.3. Existing Commercial Agreement between Sudatel and Mobitel

3.3.1 Information and Data

There are only weak commercial agreements that cover calls pricing and rent of transmission equipment, which does not cover all the aspects of a commercial agreement between the two-telecommunication operators.

3.3.1.1 Calls' prices

Table 3.32: Existing calls' prices	
Calls' price from Mobitel to Sudatel	
Call type	**Price (SDD) per minute**
Local	7.0
National	17.0
International	50% of the international price
Calls' price from Sudatel to Mobitel	
Local	9.5
National	9.5
International	9.5

As seen from the above table the charge is unfair for Mobitel and this will be a problem for any new operator. The NTC must resolve such problems, to allow for a fair market competition in telecommunication services.

3.3.1.2 Transmission Equipment's Rent

All Transmission equipment belongs to Sudatel.

There are two types of transmission prices:

A. **Transmission for Binding between Sudatel and Mobitel**

Mobitel monthly pays to Sudatel the amount of SDD 75000 for one E1 (32 channel), which performs the traffic from Mobitel to Sudatel.

B. Transmission for Mobitel's Special uses

Mobitel monthly pays SDD 150000 for one E1 (32 channel), which is especially used for Mobitel's internal connections (e.g. for binding between MSC and BTS's)

3.3.2 Data Interpretation and Analysis

3.3.2.1Information Analysis

A. Charging and Pricing

This section outlines the charging and pricing principles applicable to telecommunication Interconnection links and services. Principles are defined for facilities used by both parties e.g. interconnect links used for both way traffic.

There are many conditions concerning this subject as in chapter 2, additionally to the following Conditions which effect the competition:

- The two parties must have to provide a mechanism for fair competition between the two operators, without a reasonable price there will be no competition because the incumbent operator has the monopoly and new entrants look forward for the NTC to create a mechanism for this.
- The price must be fair
- In the telecommunication market the cost that the new entrant has to pay the incumbent operator is much higher than the vice versa
- The prices of the services must be on an unbundled basis so that a buyer doesn't pay foe unnecessary services
- For the prices there many type of pricing as seen from Chapter 2
    - Zero-Charge (bill-and-keep) and (lump- sum) payments
    - Average cost pricing
    - Price caps
    - Fully distributed cost pricing and two part tariffs
    - Ramsey Pricing
    - Wholesale pricing
    - Efficient component pricing
    - Marginal cost pricing
- The average cost pricing methods is surplus method
- The prices of services must be unbounded
- The accounting rate for international must be depending on the actual costing. And must be shared between the two operators

In the existing situation as seen from the above data, the prices between Sudatel and Mobitel are unfair and Mobitel pay to Sudatel more than the vice versa, because Sudatel is incumbent operator, and he controls the market of the communication.
So NTC must have their full authority to solve the above problems
Also not all the conditions of charging and pricing are implemented, as we said before there is only written agreements concentring the prices and the Transsimision rent .So there must be written agreements concerning all conditions of charging and pricing.
All the above points must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection agreement specifications and conditions, and NTC conditions.

B. Billing

This section shall be defined the principles and procedures for collecting billing information and settling invoice between the parties. All billing system shall be capable of being audited and tested to verify their accuracy.
All invoices shall contain the billing Verification Information as stipulated in the individual service schedules. Each party shall use the billing verification only for the purposes of verifying the accuracy of amounts charged on an invoice.
As mentioned in chapter two there are many conditions concerning billing, mainly:

- How to record the billing information
- How to switch the billing information
- Invoicing and payment procedure
- How to provide a proper Interconnection billing

In the existing situation, the billing system is not in accordance with the international billing system.
All the above points must be negotiated between the two parties and later included, in detail, in a written agreement in accordance with other international interconnection specifications and conditions, and NTC regulations.

3.3.2.2 The Financial Losses Caused by technical problems:

A. Normal faults

Table (3.33) shows examples of the negative effects of normal technical problems on the financial inputs.
When there is a call failure, we assume the customer will, on average, undertake three trials. For that cause we only consider one third of the failed calls as effective.
The data for six month
The prices are taken from table 3.32

Table 3.33 National link (ITC2)		
Period (Wed 01/06/2005 To: Thu 30/06/2005)		
Incoming	**Number of calls failed due to network performance**	**Cost (SDD)**
Signalling Failure	4,013,009	22,740,384
Technical failure	18,614,965	105,484,802
Trunk busy	22,854,822	129,510,658
Congestion	4,549,015	25,777,752
Wrong (Number or routing)	782,379	4,433,481
Wrong (Number or routing) distance	1,917,589	10,866,338
Lost Calls due to Network Performance	52,731,779	298,813,414
Outgoing		
Signalling Failure	6,239,518	19,758,474
Technical failure	2,993,445	9,479,243
Trunk busy	119,833,981	379,474,273
Congestion	932,809	2,953,895
Wrong (Number or routing)	19,570	61,972
Wrong (Number or routing) distance	1,548,660	4,904,090
Lost Calls due to Network Performance	131,567,983	416,631,946

Source: Sudatel

As seen from the table above the technical problems lead to high income losses. If there is strong interconnection agreement (with sanctions) that consider such incidences, then each operator will solve these problems as soon as they occur. For prolonged technical failures, the responsible operator has to consider paying for it.

B. Emergency Faults

In the tables below we show examples of the negative effects of emergency technical problems on the financials inputs. Same as above, we only assume that one third of failed calls are effective.
The data for seven days is shown below (the prices are taken from table 3.32):

Table 3.34 International Traffic (ITC2) (Incoming Calls from Mobitel to Sudatel)		
Day	**Number of calls failed due to network performance**	**Cost (SDD)**
17/01/2005	32,599	814,975
18/01/2005	30,797	769,925
19/01/2005	32,797	819,925
20/01/2005	**221,001**	**5,525,025**
21/01/2005	58,194	1,454,850
22/01/2005	44,268	1,106,700
23/01/2005	40,911	1,022,775
Total	460,567	11,514,175

As mentioned above, the price of the international calls from Mobitel to Sudatel is 50% prices of the call. If we assume an average price of SDD 150 for the international call, then the due financial loss on January 20, 2005 is more than 5.5 million SDD. This is almost seven times the average loss on a normal day, which is about SDD 800,000.

Table 3.35 International Traffic (ITC2)
(Outgoing Calls from Sudatel to Mobitel)

Day	Number of calls failed due to network performance	Cost (SDD)
17/01/2005	7,240	22,927
18/01/2005	7,337	23,234
19/01/2005	5,980	18,937
20/01/2005	**160,309**	**507,645**
21/01/2005	**149,013**	**471,875**
22/01/2005	9,477	30,011
23/01/2005	7,485	23,703
Total	346,841	1,098,330

As mentioned above, the price of the international calls from Sudatel to Mobitel is SDD 9.5. The due financial loss on January 20, 2005 is SDD 507,645, which is about 22 times the loss on a normal day. Similarly the same trend is repeated on 21st January 2005. The 17th January is considered as a normal day, which represents the monthly average loss per day.

Table 3.36 International Traffic (ITC2)
(Outgoing Calls from Sudatel to Mobitel)

Day	Number of calls failed due to network performance	Cost (SDD)
18/04/2005	77,455	245,274
19/04/2005	66,544	210,723
20/04/2005	**224,125**	**709,729**
21/04/2005	19,105	60,499
22/04/2005	**133,433**	**422,538**
23/04/2005	77,561	245,610
24/04/2005	87,561	277,277
Total	685,784	2,171,649

As seen from the table above, the average lost calls per day due to network performance is 75000 going from Sudatel to Mobitel. On 20/04/2005 there are severe technical problems in Mobitel side, the number of calls failed due to network performance is three times that of the normal/average day. Equally on 22nd April the same trend repeated, the loss two times that of the average day.

3.4 Existing Legal Agreement between Sudatel and Mobitel

The legal interconnection agreement must include the following:

- Interpretation: historical background (commonly called recitals) and definition of key terms
- Scope of interconnection
- Application laws
- Disputes resolution (6)

3. 4 .1 Disputes Resolution

There are two types of Disputes

- Billing disputes
- Other Disputes

Any dispute arising must be solved within the following steps:

- Initial Escalation Procedure (Interworking group from both operators)
- Authority (NTC)
- Mediation
- Arbitration
- Finally through Judicial

In the existing situation, the dispute resolution does not follow the above procedure as used in other international interconnection agreements
All the above points and the points from chapter 2 must be a subject of negotiation between the two parties and later included, in detail, in a written agreement according to other's international interconnection specifications and conditions, and NTC conditions.

4- Conclusion and Recommendations

4.1. Conclusion

- Interconnection between different telecommunication operators is necessary in order to ensure customers access to services and to each other.
- Service providers can freely negotiate interconnection terms and conditions in accordance with standard guidelines as approved by NTC
- Interconnection involves legal, commercial and technical issues, which should be included in a detailed written agreement between any telecommunication operators.
- There is an interconnection between Sudatel and Mobitel, but actually there is no written comprehensive agreement between the two companies except for terms of pricing and transmission rent.
- The existing and applied technical, commercial and legal interconnection between Sudatel and Mobitel is not in compliance with the standards.
- Sudatel and Mobitel are not fully applying the ITU recommendations concerning the technical specifications.
- Sudatel and Mobitel do not take rapid actions to resolve the technical problems and failures, which negatively affect the service and produce customer discontent.
- The congestion and signalling problems are the main factors that negatively affect the financial income of the two companies.
- It seems that NTC is not fully using its authority to regulate the interconnection between Sudatel and Mobitel as well as protect the new operators and customers.

4.2. Recommendations

4.2.1 General

- It is highly recommended that NTC enforce its authority to regulate the telecommunication business/market in Sudan. Recent developments indicate that the market is expanding rapidly. New operators are entering the market, leading to competition and accordingly conflicts and disputes may arise between the different operators.
- Interconnection agreements must be in writing and conform with: the principals of neutrality, transparency, non discrimination, fair competition, universal coverage, and access to information, equality of access and equal terms and conditions
- All licensed network operators shall have the right to interconnection with each other telecommunication network on fair and reasonable terms

The agreement must include:

- Must be complaint with other international interconnection agreements
- Provide for the scope and specification of interconnection

- Allow access to all ancillary/ supplementary services and use of premises or land to support interconnection
- Maintenance of end to end quality of service and other service levels
- Provide for billing and settlement procedures
- Right of choice of interconnect provider
- Freedom of the requesting and the requested party to negotiate between themselves
- Notwithstanding right of choice an d freedom to negotiate
- Be cost oriented
- Specify interconnection charges
- Charge for interconnection facilities and services should be fair and equitable
- Charging structure should be based on unbundled services
- Separate pricing and provisioning arrangements for least transmission links
- Technical specifications must be in compliance whenever feasible with the international standards and recommendations
- Technical and operational services between the different operators should un bundled.
- The operators' switching and transmission facilities should have the capacity to interconnect with other networks
- The following technical points must be negotiated in detail and included in the agreement:
  - Point of interconnect and interconnect level
  - Interface standards
  - Network synchronization
  - All customer services (mandatory, supplementary and intelligent services)
  - Calling line identification
  - Quality of services
  - Network design
  - Network planning
  - Forecasting
  - Network protection and safety
  - Installation and testing
  - Operation and maintenance
  - Change in the network and decommissioning
  - Provision of information
  - New requests
  - Implementation time

- The following commercial points must be negotiated in detail and included in the agreement:

  - Charging
  - Pricing
  - Billing

- The following legal points must be negotiated in detail and included in the agreement:

  - Hhistorical background (commonly called recitals) and definition of key terms
  - Scope of interconnection
  - Application laws
  - Disputes resolution

4.2.2 National Telecommunication Corporation (NTC)

It is recommended that NTC fully undertake the following responsibilities regarding:

- The national policy objectives for telecommunications
- The rights and obligations of operators in terms of their licenses
- The promotion of economic and technical efficiency
- The interests of consumers and the community
- The need to provide competition safeguards against abuse of market power
- The overall reasonableness and stated requirements of each party
- Provide the guidance when dispute arises between any two telecommunication operators
- Ensure transparency, accountability, fairness and timeliness in reaching regulatory on interconnection matters
- NTC must be involved in shaping interconnection agreements to ease the cooperation between any two Operators
- NTC can add regulatory pressure to ensure that technical, commercial and legal agreements are successful
- Pursue follow-on efforts to facilitate implementation of interconnection agreement between any two operators
- The international standards and practice, provide that interconnection disputes are resolved through following steps:

  - Inter-working group between the two parties
  - Authority
  - Mediation
  - Arbitration
  - Judicial

The following recommendations concern the protection of customer's rights:

- The availability of the widest possible range of services at the lowest prices
- The protection of customer's privacy and confidentiality of customer information
- The ability of any customer to have access to any other customer by means of the interconnection of telecommunication networks, on a seamless and transparent basis

- The ability of customers to be able to choose their preferred service provider to access local, national and international services without artificial or anti-competitive constraint limiting their choice
- The cost of telecommunication services should be affordable to the customers and unbundled in order assure access by all sectors of the community

References

(1) Eli M. Noam, "Interconnection Policy", Columbia Institute for Tele Information.
http://www.citi.columbia.edu/elinoam/articles/intercon
Accessed on: 13/05/1426

(2) The European Telecommunication Platform, "ETP - Framework Interconnection Agreement Guidelines", June 17, 1998.
http://europa.eu.int/ISPO/infosoc/telecompolicy/enintercover
Accessed on: 23/04/2004.

(3) Singtel - Newcall, "Individual Interconnection Agreement", 12th December 2000,
http://www.ida.gov.sg/idaweb/pnr/infopage.jsp
Accessed on 25/6/2005

(4) Nepal Telecommunication Authority "Interconnection guidelines",
http://www.nta.gov.np/guidelines for interconnection
Accessed on: 20/06/1426

(5) Sudatel, "Sudatel Traffic Measurement (STM)", International Traffic Department, Sudatel, Khartoum, Sudan

(6) ITU Recommendation
http://www.itu.int/ITU-T/publications/recs.html
Accessed on :04/05/2004

(7) Network for Capacity Building and Knowledge Exchange in ICt Policy, Regulation and Applications "Approaches to regulation – Basic Principles of Regulation - Managing Interconnection".
http://cbdd.wsu.edu/kew/cintent/cdoutput/TR506/page12
Accessed on: 19/06/1426

(8) Steven Andzenge "Interconnection–Legal and Regulatory Issues", Workshop on Legal issues for Judges and Legislators,Nigerian Communication Commission, Nov. 17, 2003.
http://www.ncc.gov.ng/Workshop Papers/JudgesLegislators-Nov2003/Presentation...
Accessed on:01/05/2005

(9) Sumathi Dharmawardena, "WTO Agreement on Basic Telecommunication Services- Srilanka's Experience on Interconnection and Pricing – Case Study", Dale Carnegie & Associate, Inc., 1996.
Accessed on : 17/05/2004
http://www.aptsec.org/meetings/2003/policy-forum/